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CONTENTS

	Page
University Standards and the Social Background	1069
The Conquest of Plague. By Sir Arthur MacNalty, K.C.B.	1071
Scientific Design of Absorption Towers. By Prof. H. E. Watson	1072
Naphthoic Acids and their Derivatives. By Dr. J. W. Cook, F.R.S.	1073
Basic Dynamics for Students of Aeronautics. By Prof. W. J. Duncan, C.B.E., F.R.S.	1073
The Advance of Plant Physiology. By Prof. Walter Stiles, F.R.S.	1074
The Jubilee of the Thermionic Valve. By Dr. R. L. Smith-Rose, C.B.E.	1076
Physical Research Laboratory, Ahmedabad. By Dr. K. R. Ramanathan	1078
Permanent Magnet Association : Central Research Laboratory	1080
Chemistry of Muscle Contraction. By Prof. A. Fleckenstein, Dr. J. Janke, Dr. R. E. Davies and Prof. H. A. Krebs, F.R.S. ; Dr. W. F. H. M. Mommaerts	1081
Obituary : Dr. R. S. Wilson. By J. W. Blamey	1084
News and Views	1085
New Nature Reserves in England and Wales	1088
Institute of Personnel Management : Annual Conference. By T. H. Hawkins	1088
Nutrition and the Alimentary Tract in Man	1090
Ferroelectric Properties of Single Crystals. By C. F. Oxbrow	1091
Shift Work in Industry	1093
Forestry Commission : Report for the Year 1952–53. By Prof. E. P. Stebbing	1093
Manufacture of the Ten-Tola Primary Standard Weight for Pakistan. By Dr. G. F. Hodsman	1094
The *O* Chromosomes and the Distribution of the Dental Fricatives in Europe. By R. W. Thompson	1095
Measurement of Rhodopsin in the Living Human Eye. By Dr. W. A. H. Rushton, F.R.S., and Dr. F. W. Campbell	1096
Letters to the Editors :	
Infra Red Spectra of Coals.—R. R. Gordon, W. N. Adams, G. J. Pitt and G. H. Watson	1098
Heats of Reaction during Carbonization as deduced from Temperature Surveys of a Coke Oven.—D. J. Millard	1099
'Reaction Time' of Cast Trinitrotoluene as a Function of the Rate of Charge Cooling.—W. M. Evans and T. C. Tranter	1100
Oxidation Changes in Natural Ilmenite.—C. E. Curnow and L. G. Parry	1101
Flow Potentials in Hyaluronate Solutions.—C. E. Jensen, Jørgen Koefoed and Thure Vilstrup	1101
Protective Effect of *d,l* α-Octadecylglycerolether in Mice given Total Body X-Irradiation.—T. Edlund	1102
Alkoxyglycerols in the Treatment of Leukopænia caused by Irradiation.—Astrid Brohult and John Holmberg	1102
Exchange of ^{14}C-Glucose-1-phosphate with Uridine-diphosphate-glucose by the Galacto-Waldenase System.—Dr. Raul E. Trucco	1103
Alternate Pathways of Glycerol Oxidation in *Acetobacter suboxydans*.—Jens G. Hauge, Tsoo E. King and Prof. Vernon H. Cheldelin	1104
Mechanism of the Formation of Red Melanin in the Silkworm.—Kaoru Inagami	1105
Primycin, a New Antibiotic.—Prof. T. Vályi-Nagy, J. Uri and I. Szilágyi	1105
Adrenocorticotrophic Activity of Melanophore-expanding Hormone Preparations from Beef Pituitary Glands.—Dr. B. G. Benfey, Dr. M. Saffran and A. V. Schally	1106
Salicyloylhydrazide : a Reagent of Wide Use in Organic and Histochemical Analysis.—Dr. B. Camber	1107
Lingual Proprioception in Pig, Dog and Cat.—Mary E. Law	1107
Presence of Zinc in Nucleoli and its Possible Role in Mitosis.—Dr. T. Fujii	1108
Stability in Development and Relational Balance of X-Chromosomes in *Drosophila melanogaster*.—G. Tebb and Dr. J. M. Thoday	1109
Liberation of Amino-acids by Plant Roots in Relation to Desiccation.—H. Katznelson, J. W. Rouatt and T. M. B. Payne	1110
Variation of the Shells of *Murex tribulus* from the Great Bitter Lake, Egypt.—Dr. Monica Taylor	1111
A Hydropolyp in the Biological Cycle of a Freshwater Jellyfish.—Dr. J. Bouillon	1112
"Sixth Commonwealth Entomological Conference."—Dr. C. H. N. Jackson ; The Writer of the Article	1112

UNIVERSITY STANDARDS AND THE SOCIAL BACKGROUND

AN article by R. K. Kelsall on the social background of the higher Civil Service in Britain, in the current issue of *The Political Quarterly*, is based on data obtained as part of a wider study to be published next year. The article suggests that there has been a marked alteration in the social background pattern of candidates presenting themselves for examination, and that the main hope of ultimately securing a more equal representation of those originating in the lower social strata still lies in more widely dispersed educational opportunities, and in the maintenance and possible expansion of the present more liberal policy of promotion from the ranks. It recognizes that, before the Second World War, most successful candidates had been at the University of Oxford or of Cambridge, due largely to the fact that relatively few candidates who had been to other universities presented themselves. The other universities are, however, better represented in post-war candidates generally, though most of them still contribute very much less than the appropriate share of competitors for entry to the administrative class, and thus to some extent contribute to the lack of social balance among the entrants.

Some further light is thrown on this question, which clearly may affect the ability of the administrative class both to draw on the full reserve of intelligence in the population and to maintain full touch with the citizens it serves, from a recent broadsheet, "Background of the University Student", issued by Political and Economic Planning (No. 373 ; November 8, 1954). The broadsheet compares the results of a survey at one of the two ancient universities, two English provincial universities, a university college, a college of the University of Wales, and a college of the University of London in 1952–53 with those of a previous survey at the same institutions in 1947–48. In both surveys the information required was extracted from university records, and afterwards arranged and analysed on a similar basis.

As might be expected, on account of the departure of ex-Service students, there was a marked shift towards the younger age-groups for men students in the second survey ; but no clear conclusions regarding the effect of national service on the age at entry can yet be drawn. Some institutions seem to bring most of their students up before they have done their national service, while others, notably the ancient universities, bring them up afterwards. The proportion of British students whose homes are near the universities they attend is still fairly high, except at Oxford and Cambridge ; but it has fallen steadily since the Second World War. At London, the percentage of students with homes within thirty miles of the University increased from 47·4 per cent in 1937–38 to 56·2 per cent in 1947–48 and fell to 52·7 per cent in 1952–53 ; for other English universities and university colleges (excluding Oxford and Cambridge) the corresponding figures are 64·0, 58·4 and 43·7, and for Wales 64·7, 53·5 and 48·2.

The P E P surveys show that while the proportion of men students entering the ancient university from other universities or technical colleges remained almost unchanged (22 per cent in 1952–53 compared with 21 per cent in 1947–48), the percentage entering from fee-paying schools decreased from 52 to 46, while the percentage of students from non-fee paying schools (local authority schools) increased from 21 to 27 per cent; for women students similar figures were observed—a decrease from 51 to 47 per cent and an increase from 30 to 38 per cent, respectively. At one provincial university and at the university college there was a striking increase in the proportion of students coming from other universities and technical colleges, and at the London college where, in 1947–48, 34 per cent of men and 28 per cent of women students came from this source, there was a slight increase. At the other provincial university there was little change in the percentage of men students so recruited, but an increase in the proportion of women students; while at the Welsh college the percentage of men and women students so recruited declined from 11 per cent and 5 per cent, respectively, to 5 per cent and 1 per cent.

This second survey confirms the observation made in the first survey—that, whereas ex-Service students at the ancient universities coming from independent public schools had not been seriously affected by competition from the former pupils of grammar schools, competition from school leavers seemed to be growing more severe. At four of the other institutions the shift was in the same direction, although at the London college it was slight, and at one other institution it was slight. For women students the changes have been in contrary directions. But apart from these aberrations, the representation of the State secondary schools at the universities of Britain has been strengthened during the five years. For men students only the ancient university now has a larger proportion coming from fee-paying schools, and the gap is narrowing; apart from foreign and Colonial students, the Welsh college and the university college are virtually preserves of the State schools, and a recent survey by P E P of the University College of North Staffordshire showed that an average of 81·2 per cent of its men students and 79·8 per cent of women students came from State schools.

Analysis of the occupations of parents of United Kingdom students was based on seven groups: professional, administrative, proprietors and managers; forces, police, fire service, etc.; farmers; personal services; retail traders, innkeepers, etc.; clerks, shop assistants, salesmen, etc.; and manual workers. At all four institutions there has been a shift towards the latter end of the scale; even at the ancient university the last two groups increased their representation by seven per cent for men and one per cent for women at the expense of the first two groups. Elsewhere among men students the representations of the last two groups have risen from about a third to about one-half of the total, and there has been a similar change among women students; but even at the Welsh college it is still true that women students tend to come from higher social groups than their male colleagues.

Further analysis of the first occupational group indicates that in the five-year period the proportion of students whose fathers are higher Civil servants or senior officials in local government has decreased, and also the proportion of students whose fathers are in business, either on their own account or holding senior managerial positions. A recent analysis of students registered at Hull University College (now the University of Hull) showed that thirty-four per cent are of working class origin, while the earlier P E P survey showed that this figure for the ancient university was seven per cent and at provincial universities twenty per cent. The broadsheet also quotes from two other recent studies of the social and educational backgrounds of students covering more limited fields. H. Jenkins and D. Caradog Jones's study of "The Social Class of Cambridge Alumni" showed that the proportion of public school men at Cambridge rose during the second half of the nineteenth century, being eighty-two per cent during 1850–99, until the growth of local authority secondary schools brought about a decline to sixty-eight per cent in 1937–38. Since only the ablest pupils from grammar schools went up to Cambridge, these students had the best academic record over the whole period 1752–1899, although they were less successful in their careers than the products of famous public schools. Schools or families of high social standing had a definite relation to securing posts of distinction, though not those of the highest importance; but apart from this bias, successful students at Cambridge usually did well in later life.

C. A. Anderson and M. Schnaper's survey of the social background of Oxford and Cambridge students was based on individuals at the university between 1850 and 1900, and indicated the extent to which the older universities provided for the education of men who achieved or inherited eminence in later life. Men who made their names in government service had the most diversified educational background; but at that time the older universities did not dip very deeply into the social pyramid. The most noticeable feature was for Oxford and Cambridge to have the lion's share of great men, with a marked tendency for sons to follow in their fathers' footsteps.

Replying in an adjournment debate on local authority awards to university students in the House of Commons on November 17, the Parliamentary Secretary to the Ministry of Education, Mr. Dennis Vosper, made some relevant comments. As a result of university expansion, the number of students of any age-group going to a university was about double the pre-war number, and in each age-group a much greater cross-section of the social strata was represented. Even if there was not equality of opportunity from area to area, he said, we have moved much nearer to equality of opportunity so far as the income of parents and social background are concerned. In 1953 the universities took 1,250 open scholars, 2,000 State scholars and 10,000 students

with local authority awards; more than 70 per cent of the 18,000 students entering the universities in that year were thus in receipt of awards.

Mr. Vosper stressed the great increase in local-authority awards, which in 1938 were only 1,500, and in 1953 had cost almost £6 million compared with £2 million in 1948. While university and State scholarship awards are for students of outstanding academic ability, local authority awards are intended to assist students of good all-round ability for whom it is in the public interest that a university education should be provided. The procedure at present in force, he said, leaves responsibility with the local authorities, which are asked to consider all candidates with a minimum academic standard, but are left some discrimination and particularly with reference to the headmaster's report and interview panel. Only six out of 146 authorities in Britain do not now accept the minimum standard laid down in the Circular of 1952, and Mr. Vosper thinks that, apart from the six authorities noted, there has been much improvement in uniformity of standard and equality of opportunity. The universities at the moment do not feel able to undertake the work involved in making an award dependent on acceptance by a university, and while it might be possible for the Ministry of Education to select the two thousand State scholars each year on academic achievements, he does not think it possible for the Ministry to select ten thousand students of all-round ability.

Without over-stressing the value of these partial surveys, it is clear that these trends, of which the University Grants Committee, from its last quinquennial report, is clearly aware, pose problems of which the universities must increasingly take account pending the completion of the inquiries now being carried out by the Committee of Vice-Chancellors and Principals and by P E P itself. The former inquiry is expected to furnish, in due course, a mass of information about the educational and social origins of university students, as well as about their qualifications, awards held and courses followed, and the reasons for rejection of unsuccessful candidates. The second is concerned with graduates—and especially with graduates in industry—and should also provide material of use to the universities as well as to industry.

On the evidence now presented, even if the proportion of students coming from homes within a short radius of the provincial universities does not increase, the shift in the social strata from which students are drawn may well accentuate the difficulties which arise when a considerable proportion of students is drawn from homes with no tradition of culture. It is not a problem to be solved merely by the increase in financial grant or by the more generous provision and equipment of libraries and halls of residence.

The inquiry into ways of learning by students of university age which the University Grants Committee has sponsored, and which is being conducted by Sir Godfrey Thomson under the auspices of the University of Edinburgh, should go closer to the heart of the matter. What is involved is an attitude of mind that is endangered by the deficiencies of home life and conditions or by relative poverty, and which also is discouraged by the tendency of the times to rely on the State rather than on individual effort or initiative. It is also in part a question of values; and unless this problem of the attitude to learning and of cultural and intellectual values is faced and solved, there is danger that the State will receive little or no return from the six million pounds now being spent annually on university awards by the local authorities alone.

There are other disturbing consequences at which the surveys already published hint. It may be questioned whether the dominance of students from the State schools will not endanger the full value of the experiment which has been proceeding at Keele for the past four years. Diversity of entry offers, for the moment, a hope of correcting some of the more serious consequences which may flow from the present trend in the background of the university student. At least it may be said that the evidence of the P E P broadsheet affords strong support for caution in regard to university expansion, and endorses the view already expressed by the University Grants Committee that the main immediate task of the universities is consolidation. Adjustments to meet particular needs of the community and the improvement of methods of selection are important indeed; but the primary task is that of so adjusting the teaching work and responsibilities of the university to the changing types of student that successive generations of student will continue to acquire the same secret of learning, to catch the same inspiration, and to carry away with them the same powers of vision and imaginative understanding as did those who in former years entered the universities with greater social and cultural advantages.

THE CONQUEST OF PLAGUE

The Conquest of Plague

A Study of the Evolution of Epidemiology. By Dr. L. Fabian Hirst. Pp. xvi+748. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 42*s*. net.

THIS is a comprehensive study of plague. The author, Dr. L. Fabian Hirst, is a microbiologist who, as Lieut.-General Sir William MacArthur writes in a foreword, during a period of twenty-two years has paid special attention to the disease in various parts of the Middle and Far East, particularly in Ceylon.

Part 1 of the book deals with traditional conceptions of the nature of plague. Dr. Hirst reminds the reader that primitive beliefs and observations may hold truths that are only revealed to the man of science centuries later. Instances of this are the epidemics of plague among the Philistines, described in the Old Testament (I Samuel, v, vi), which are associated with the presence of small rodents. The Hebrew word *akbar* may mean rat or mouse. If the civic authorities of London had read their Bible

more carefully, they would not have favoured the rat population in ordering the destruction of cats and dogs as possible vectors of plague in 1665. Dr. Charles Singer has pointed out that during the seventeenth century natural causes were first assigned to plague, and even that it was due to the multiplication of minute organisms, a hypothesis not verified for two hundred years.

Concerning the spread of the disease, miasma versus contagion was for centuries the subject of debate, and it was not until the middle of the nineteenth century, when Sir John Simon organized careful investigation of plague outbreaks as recorded in his "Annual Reports" to the Privy Council, that scientific opinion progressed from the conception of a miasma emanating from putrefying filth to a specific chemical poison in air and water, and, finally, to the modern view that specific infections are due to invasion of the body by specific micro-organisms. In his historical narrative Dr. Hirst demonstrates how the study of plague has played an important part in the general evolution of epidemiology. The plagues of London, the Marseilles epidemic of 1720–21, the "Short Discourse concerning Pestilential Contagion" of Richard Mead, which advanced knowledge of the disease and its control by quarantine, all these historical landmarks receive careful attention.

To those engaged in work on plague, whether as research worker, administrator or medical practitioner, the remaining three parts of this work will be of special interest. In these parts the author considers the modern conceptions of the nature of plague, its spread in time and space, its conquest and its international and national control. Here Dr. Hirst has drawn freely upon his own researches dealing with the parasitological and preventive aspects of the disease. It is all most systematically and carefully done. On the vexed question as to whether Kitasato or Yersin discovered the bacillus of plague at Hong Kong in 1894, Dr. Hirst examines the evidence and states (p. 108): "The conclusion must be that both bacteriologists discovered the plague bacillus independently within a few days. Kitasato saw it first, but Yersin, the former *préparateur* of the Pasteur Institute, was probably the more accomplished technician and gave by far the best description of the micro-organism".

There are interesting studies in the book of rats as transmitters of plague, of the classification of the fleas which convey plague, together with a full account of plague among the rodents of the great plains. The author then describes inter-human plague; the temporal spread of plague, together with a consideration of the periodicity of epidemic disease; and the territorial spread of plague. Last of all he discusses administrative measures for the prevention of plague and, from a wealth of experience, points out the difficulties and pitfalls, as well as the successes, of the measures pursued. This portion of the book might have been expanded with advantage; but Dr. Hirst records the chief steps in international control of plague and its prevention, and a second volume would be required to treat the subject exhaustively.

In an epidemiological treatise only brief reference is possible to the successful modern treatment of plague. Formerly, the early injection of a fresh and potent anti-plague serum was the chief method. Since the introduction of the sulphonamides by Domagk in 1935 it has been shown that plague can be successfully treated by certain of these preparations. Later still, some of the new antibiotics, especially streptomycin, have proved even more efficacious. Penicillin, the best known of these, does not act on the plague bacillus.

This erudite work, which investigates many aspects of a deadly but now a controllable disease, is clearly written and can be read with profit by both lay and medical readers. The book is appropriately illustrated and well produced. ARTHUR S. MACNALTY

SCIENTIFIC DESIGN OF ABSORPTION TOWERS

Absorption Towers

With Special Reference to the Design of Packed Towers for Absorption and Stripping. By G. A. Morris and J. Jackson. Pp. xi+158+3 plates. (London: Butterworths Scientific Publications in association with Imperial Chemical Industries, Ltd., 1953.) 30*s*. net.

THE design of absorption towers is a complicated process owing to the large number of factors involved and the irregular flow conditions which are often encountered; it was not until the middle 'thirties that any success was achieved. The two-film theory was available as a suitable basis; but the real clue to scientific design was given by the development of the comparatively simple grid-packing together with the surprisingly belated recognition of the fact that for best performance it is essential to have uniform liquid flow over the surface of the packing. Even now, mere wetness appears sometimes to be regarded as satisfactory, although this is by no means always the case. While the general principles of design have not appreciably changed since 1937, many improvements have been introduced and much data accumulated. Making full use of these and a great deal of hitherto unpublished information, G. A. Morris and J. Jackson have produced a monograph of outstanding merit. In spite of the complexity of the subject, the clarity of presentation is such that, with the help of this book, anyone with some knowledge of physical chemistry should be able to design an absorption tower.

A brief introduction to the subject of absorption is followed by a chapter on the determination of film coefficients by laboratory methods and by one on packings. Two methods of design—in other words, calculation of the most economical dimensions of the tower and the best type of packing—are elaborated, one using absorption coefficients and the other transfer units, and their relative merits are discussed. Economic factors are treated separately, and a table of economic gas-rates for different packings will be found of much assistance. A very valuable chapter on the mechanical features of design is largely devoted to the important subject of liquid distribution already mentioned, and a number of fully worked-out examples are appended to assist in applying the principles discussed in the main part of the book. To conclude, a glossary is added, in which exception must be taken to the authors' use of the not altogether accurate term 'gas-film limitation' instead of the older and more usual 'gas film control'.

Special features are the comprehensive tables and well-drawn diagrams which supply practically all the

facts required by the designer, thereby saving him from the inconvenience of continual reference to bulky volumes of tables. A minor omission is a table of heats of solution, while a welcome item rarely found in British books is an indication of the price of the main components of the plant. Absorption calculations unfortunately require the use of a great many symbols which are difficult to remember; but the reader is helped in the present book not only by a six-page summary at the end of the volume but also by an explanatory list after each important formula, a practice much to be commended. Units are often a source of confusion: the C.G.S., British and metric systems are all used, but the first is confined to the laboratory section. Both British and metric values are given in the tables, the figures being set out with such clarity that a mistake is well-nigh impossible.

One omission, no doubt intentional, is greatly to be regretted—the complete absence of data for the performance of existing large towers and comparison with calculated values. This tends to impart an academic atmosphere to the book, despite its obviously practical nature. The authors emphasize that large towers are difficult to test, that some of the design methods recommended are still tentative, and that it is sometimes desirable to introduce factors of safety; but a few definite figures for the discrepancies actually found would indicate the reliance to be placed on the calculations. Apart from this, the book is a model of the way in which to treat a complex chemical engineering subject and is a particularly good example of the application of science to industry. All chemical engineers will adopt it as a standard work of reference, and all chemical manufacturers should study it. H. E. Watson

NAPHTHOIC ACIDS AND THEIR DERIVATIVES

Elsevier's Encyclopædia of Organic Chemistry
Edited by F. Radt. Series 3: Carboisocyclic Condensed Compounds. Vol. 12*B*: Naphthalene. (*A*) Compounds Containing One Naphthalene Nucleus. Naphthoic Acids and Their Halogen, Nitrogen, and Hydroxyl Derivatives. Pp. 3965–4560. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1953.) £21 net. (Series Subscriber, £18 10*s*.; Complete Subscriber, £16.)

THIS seventh part of Vol. 12*B* makes a useful addition to the section of the Encyclopædia dealing with naphthalene derivatives. The seven parts together already constitute an impressive survey of naphthalene chemistry, but the end is not yet in sight. Part 7 is concerned with the two naphthoic acids and their hydrides and homologues, together with the usual types of acid derivatives, and various substitution products containing halogen, nitrogenous groups, hydroxyl and alkoxyl. Polycarboxylic acids derived from naphthalene will find a place, presumably, in Part 8. As is usual with such a method of treatment, the result is an assembly of information about an assortment of compounds which will appeal to a variety of tastes.

For the natural product chemist there is an interesting review of the recent chemistry of naturally occurring lactones derived from naphthoic acids. These comprise the conidendrins and the constituents of 'podophyllin'. As regards the latter, the structural relationships between podophyllotoxin and picropodophyllin and their derivatives are set forth in a characteristically clear chart of formulæ. These substances have aroused some interest among biologists on account of their destructive action on certain pathological growths. The chemical reader who consults the index may well wonder what is an 'oncolytic' compound. If he refers to the text, he will find that it is a substance with tumour-damaging activity.

For the dyestuffs chemist there are surveys of aminonaphthoic and hydroxynaphthoic acids. The anilide of 2-hydroxy-3-naphthoic acid (Naphthol *AS*) and its applications are fully discussed; many azo dyes derived from this and related compounds are described, and there is a table occupying fifteen pages which summarizes the properties of the many known arylamides of 2-hydroxy-3-naphthoic acid. For the pharmacological chemist there are descriptions of many compounds with local anæsthetic activity derived from the aminonaphthoic acids.

There are the usual references to physical constants, including optical data, and to biological properties as far as these have been recorded. For 1-naphthonitrile, for example, the ultra-violet absorption maxima and Raman frequencies are given, as well as the fluorescence, phosphorescence and magnetic properties, the dielectric constant, the heat of combustion and the density. Its polyploidogenic action is also mentioned. The only misprint which has been noted is an obvious one, in a heading on p. 4009. The high standard of previous parts of this Encyclopædia is well maintained. J. W. Cook

BASIC DYNAMICS FOR STUDENTS OF AERONAUTICS

Introduction to Aeronautical Dynamics
By Prof. Manfred Rauscher. Pp. xv+664. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 96*s*. net.

AERONAUTICS is, with the possible exception of astronomy, the subject in which the greatest and most diverse applications of classical mechanics are made. These applications cover problems of the dynamics of particles and of rigid and deformable bodies, oscillations of many kinds and the whole field of the mechanics of fluids. Investigations of great difficulty and much technical importance arise in which the system consists of a deformable body (aircraft) in motion through a viscous and compressible fluid (air). Questions of the stability of motion are of great importance, while thermodynamic considerations are essentially involved in the problems of propulsion and of high-speed flight in general. All this implies that aeronautical scientists and engineers must be well versed in dynamical techniques, some of which have indeed been specially devised for the treatment of aeronautical problems, while students must have a thorough training in dynamical fundamentals. It is these fundamentals which the book under review aims to provide.

Dynamical theory may be regarded as composed of three parts: kinematic theory, dynamical principles, and mathematical techniques for the solution of problems. Kinematic theory is based only on pure geometry and the concept of time and is thus not,

properly speaking, dynamics at all. However, the analysis of every dynamical problem must begin with a thorough kinematic investigation, and when this has been made and the results assimilated, the application of the truly dynamical principles is usually easy. In my opinion, the importance of kinematics has been greatly under-estimated in recent times. It is therefore pleasing to find that due attention to kinematics is paid in this treatise. The first chapters cover basic kinematics, the dynamics of a particle and the dynamics of sets of particles. Next, Chapters 4–7 give an outline of the kinematics and dynamics of fluids, with sections on vortices and the application of the complex variable, while Chapters 8–9 are concerned with the theory of aerofoil in two and three dimensions. Chapter 10 deals very briefly (and it must be said, too briefly) with viscosity, turbulence and the applications of dimensional analysis. The next two chapters are concerned with the kinematics and dynamics of rigid bodies, and the final chapters deal with the oscillations of dynamical systems having one or a larger finite number of degrees of freedom.

I can sum up my opinion of this book by saying that it gives a competent account of basic dynamics for students of aeronautical engineering from the point of view of one experienced teacher. Many readers will be disappointed to find that the more advanced topics of aeronautical dynamics, such as the theories of stability and control and of flutter, are not discussed at all. The title of the book is, indeed, rather misleading in this respect.

W. J. Duncan

THE ADVANCE OF PLANT PHYSIOLOGY

Annual Review of Plant Physiology

Edited by Daniel I. Arnon, in association with Leonard Machlis. Vol. 5. Pp. x+400. (Stanford, Calif.: Annual Reviews, Inc., 1954.) 7 dollars.

With the publication of its fifth volume the "Annual Review of Plant Physiology" may claim to be well established. The present volume follows the same lines as its predecessors and contains fourteen articles on different aspects of plant physiology. While some of these cover a wide field, such as that on tropisms and nastic movements (L. Brauner), or deal with subjects of considerable appeal to plant physiologists, such as the long article on photosynthesis (R. Lumby, J. D. Spikes and H. Eyring) with no less than 401 references, that on the connected subject of the photosynthetic function of pigments other than chlorophyll (L. R. Blinks) and the one on the occurrence, formation and inactivation of auxins (S. A. Gordon), others deal with matters of which knowledge is perhaps not so widely distributed, even among plant physiologists. Among such might be included the articles on the physiology of plant tumours (A. C. Braun), dormancy in woody plants (R. M. Samish), the post harvest physiology of fruits and vegetables (W. T. Pentzer and P. H. Heinze), the physiological aspects of fungus diseases of plants (P. J. Allen), and the role of plant physiology in plant geography (H. L. Mason and P. R. Stout). Yet, with the exception of the last-named, none of these articles has less than a hundred references to literature.

Of the subjects dealt with in the present volume, perhaps those in which advances in knowledge are most spectacular concern enzymes. One of these, by W. D. McElroy and A. Nason, is on micronutrient elements in enzyme systems; the other, by D. A. Goddard and H. A. Stafford, deals with the localization of enzymes in the cells of higher plants. A perusal of these reviews cannot fail to impress on the reader the real progress that has been made in these subjects during the past few years. Thirty years ago, that such things as trace elements were essential for plants had scarcely been accepted by plant physiologists in general. Ten years ago, by which time the necessity for trace elements was well recognized, their function was obscure and a matter for conjecture. The article by McElroy and Nason now shows strikingly how widespread is the necessity for one or other of these elements for the activation of enzymes. Iron and copper enzyme systems, as well as some involving magnesium, have been known for some time, but now McElroy and Nason list more than twenty enzymes which are activated by manganese, and they conclude that manganese is the chief metal concerned in general enzymatic decarboxylation and hydrolysis. Zinc and magnesium appear to be similarly involved to some extent. Manganese, though not to the same extent as magnesium, appears also to be required for enzyme actions involving group transference. Copper, iron and molybdenum are concerned with electron-transferring systems.

A few years ago knowledge of the subject here dealt with by Goddard and Stafford was negligible. Now at the end of their article on the localization of enzymes in the cell they list 101 references, 90 per cent of which refer to publications that have appeared not earlier than 1950. The extension of knowledge of enzyme systems to include their localization in the cell has resulted from the new technique of differential centrifugation of cell-free homogenates, by which a partial separation at least of cell constituents such as nuclei, plastids, mitochondria and microsomes is attempted. While the authors of the review show that the results so far obtained must be accepted with caution, it seems clear that the development of this line of investigation gives promise of information of the greatest importance in the not distant future.

Another article dealing with a new development is that on soil conditioners by J. H. Quastel. While the importance of the natural soil conditioner, humus, has been known for centuries and, maybe, thousands of years, it is only during the past few years that the possibility of using synthetic substances for improving poorly aggregated soils has been indicated. This article gives a clear account of the nature of the synthetic soil conditioners and their effects on soil, and will be read with interest by pedologists as well as by plant physiologists.

The remaining two articles are on nutrition by foliar application (D. Boynton), and the mineral nutrition of phytoplankton (B. H. Ketchum). The former, concerned as it is with the effect of sprays, will be of particular interest to pomologists, while the latter will be of special appeal to that growing band of physiologists who use unicellular algae, as providing reproducible material, for their investigations. Once again the editors and contributors are to be congratulated on providing for their fellow plant physiologists a most useful and welcome volume.

Walter Stiles

The World of Learning, 1954

Fifth edition. Pp. xii+1030. (London: Europa Publications, Limited, 1954.) 100*s*. net.

THE fourth edition of the "World of Learning" was published in 1947, and though it was very useful at the time to have this reference book so soon after the Second World War, it was not really so valuable as it at first sight seemed, in that the information relating to a number of countries that had been devastated by the War was not up to date. The new fifth edition, besides being as up to date as such a compilation as this can be, is a good deal enlarged; in particular, it opens with a new section on Unesco, giving its origins, aims, functions and organization as well as an account of its recent activities, and this is followed by a list of the principal international scientific organizations, with brief statements of their objects and the names of their main officials.

The rest of the book follows the plan of the previous edition. It is divided alphabetically (by English name) into the various countries of the world, and, where the entries for a country are sufficiently numerous, a contents list is given. The arrangement of entries for Great Britain gives an idea of the range of institutions, etc., covered: learned societies and professional associations; research institutes; libraries; museums and art galleries; universities and university colleges; centres for adult and technical education; schools of art, music and dramatic art; and educational trusts. Naturally, the range of headings varies somewhat from country to country. In general, the entry for each institution contains its address, the names of the leading officials and the date of foundation, and for each university a complete list of all the professors is given. Where applicable, the titles of publications issued by the body concerned are listed. A useful section of the book is that on the U.S.S.R., which is twenty-nine pages long; no universities are quoted, but a very full list of the numerous higher educational institutions and research establishments in the U.S.S.R. is given.

The book ends with a fifty-four page index of institutions, with more than two hundred entries per page. There is no name index. Other reference books exist covering universities and the more academic bodies to be found in the various countries of the world, and in this particular field the "World of Learning" is no more comprehensive, probably less so. But where it scores over the other books is in the very complete lists of non-university organizations such as learned societies, professional organizations, museums, etc., and for this it can be recommended.

Public Health Engineering

By Peter C. G. Isaac. (Spon's Civil Engineering Series.) Pp. xvii+277. (London: E. and F. N. Spon, Ltd., 1953.) 36*s*. net.

THE average member of the public in Britain is apt to take things for granted and has little conception of the magnitude and complexity of the undertakings which deal with unhealthy products and supply him with pure water, 10–15 per cent of which he wastes. These and kindred activities are now classed under the heading of public health engineering, and this book under review is a welcome introduction to the subject. Nearly half of it is given up to water, its sources, collection, quality, analysis, treatment and distribution. Fifty pages are devoted to sewage and its purification—the ever-growing problem of river pollution is given a separate chapter—and the methods of treatment of trade wastes are illustrated by a number of specific examples. After discussion of refuse disposal and atmospheric pollution, the author concludes with a chapter on district heating, a subject which scarcely comes under the heading of sanitary engineering but one which is to be welcomed in view of its importance and the necessity of propaganda to induce the British public to revise its ideas on the subject of warming houses.

It is obviously impossible in one small volume to deal with all the subjects mentioned above in any detail, but the author has succeeded in giving an immense amount of information and, in addition, in presenting it in a readable and interesting manner. As the result of a stay in the United States, he has been able in many cases to quote American practice and to compare it with British, and there can be few people, even among sanitary experts, who will find nothing that is new to them. For the benefit of those wishing to go more deeply into a subject, numerous references are given at the end of each chapter. "Public Health Engineering" was written primarily for students and sanitary engineers; but it is to be hoped that it will attract the attention of a far larger circle of readers, since the matters dealt with are of vital importance to all. H. E. W.

Table of Binomial Coefficients

Prepared for the Mathematical Tables Committees of the British Association and the Royal Society, under the Editorship of J. C. P. Miller. (Royal Society Mathematical Tables—Vol. 3.) Pp. viii+162. (Cambridge: At the University Press, 1954.) 35*s*. net.

THIS volume is actually the second of those to appear under Royal Society auspices as a consequence of the Cunningham Bequest of 1928, the first being E. H. Neville's "The Farey Series of Order 1025" (1950). Many establishments have co-operated in its production, including the National Physical Laboratory and the Royal Aircraft Establishment. As the computation of the tables was fairly simple, there is no need for a lengthy introduction. The basis of the calculations was the elementary recurrence formula of Pascal's triangle, and no further details or formulæ have been included.

All the tabulated values are exact, in order to meet the requirements of number theory (the primary object of the Cunningham Bequest). For values of n up to and including 200, every value of the binomial coefficient $\binom{n}{r}$ for each value of r up to $\frac{1}{2}n$ is supplied, and the maximum coefficient (or pair of coefficients) appears in bold type. This tabulation, which forms the main part of the book, occupies a hundred and three pages in all. The remaining sixty pages are devoted to higher values of n, as far as 5,000, with corresponding entries for small values of r only, first up to 12 and then (as n increases) 11, 5 and finally 3.

A page index, showing at a glance where any particular coefficient may be found, is supplied on p. 1, and there is also a list of references to publications used or consulted. The whole book is beautifully produced, in the highest traditions of the Cambridge University Press. J. H. PEARCE

THE JUBILEE OF THE THERMIONIC VALVE

On November 16, 1904, Prof. J. A. Fleming first described, in British Patent Specification No. 24850, the application of a two-electrode thermionic valve to the rectification of alternating currents of high or, as we now term them, radio frequencies. The jubilee of this invention was celebrated on November 16 last at a special meeting of the Institution of Electrical Engineers, at which lectures on the history and development of thermionic devices were given, and an exhibition of some 240 different types of valves was opened. The widespread interest in the occasion was evident from the fact that the members present filled to capacity the lecture theatre of the Institution.

Earlier in the day, the Marquess of Salisbury, Lord President of the Council, unveiled a plaque to the memory of Sir Ambrose Fleming, F.R.S., at University College, London, the birthplace of the valve, where Fleming was professor of electrical engineering during 1885–1926. Lady Fleming was present at this ceremony, at which Lord Salisbury recalled that this invention of the thermionic valve was the starting-point for the vast developments of the present day in the field of electronics.

During the period November 16–18, an exhibition was held in the Electrical Laboratories of University College, at which were displayed a large and historical collection of lamps, valves and electrical measuring equipment which, together with laboratory and lecture manuscript notebooks and a collection of published works, represented Fleming's wide range of interests and great contributions to electrical engineering. It was very appropriate that the exhibition should include demonstrations of current research in progress in the College laboratories, illustrating new techniques for measurement at very high radio frequencies and the study of wave propagation along conducting surfaces.

The meeting at the Institution of Electrical Engineers was opened by Lord Salisbury, who directed attention to the significance of the discovery of the thermionic valve by Sir Ambrose Fleming, whose inspiration carried him far beyond the work of previous investigators and so enabled him to add further lustre to the record of British scientists. Lord Salisbury referred to the fact that the birth of the thermionic valve was one of the most far-reaching events of the past half-century; and he directed attention to the remarkable technological applications to which the principle of the valve pointed the way. Wireless transmission, broadcasting, television, radar and radio aids to navigation and surveying, he pointed out, have all been exploited within the past few decades; and we appear to be only just at the beginning of a vast new era of the application of electronics to industrial techniques and processes. Many of the necessary processes of modern industry —sorting, testing, measuring, etc.—are fatiguing and boring tasks, and much progress has been made, particularly in the United States, in exploiting the new techniques, which open up a vista of relief from exhaustion and increased leisure for the whole working population. Lord Salisbury concluded his address with the following remarks: "Let us, then, regard this jubilee not only as an occasion for looking back with thanks and admiration to Sir Ambrose Fleming for all that we owe him, and with gratitude to those who have followed him, but also as an occasion for looking forward, for straining forward, towards that land of promise which his genius has brought within our sight, and almost within our grasp".

The president of the Institution, Mr. J. Eccles, then welcomed Lady Fleming and expressed the hope that she would find that the large number of members present had assembled in a sincere effort to pay tribute to the great work of her late husband.

Prof. G. W. O. Howe then delivered a lecture entitled "The Genesis of the Thermionic Valve", in the early part of which he outlined Fleming's early life and education at the University of London and later at Cambridge, where he studied under Clerk Maxwell. While holding an appointment with the Edison Electric Light Co., Fleming visited the United States in 1884, when Edison exhibited an interesting discovery which he had made the year before. He had fixed a metal plate in the bulb of a carbon filament lamp, and he found that a current flowed through a galvanometer connected between the metal plate and the positive terminal of the filament. No current was indicated, however, when the connexion was made to the negative terminal of the filament. This phenomenon, which was afterwards known as the 'Edison effect', was applied to the control of the mains voltage in a power station, but Edison made no use of it for telegraphy. This matter greatly interested Fleming and he conducted several investigations on it from 1890 onwards, in the course of which he showed that a similar but smaller effect was obtained when platinum was used instead of carbon for the incandescent filament.

Nearly ten years later, when Fleming had become scientific adviser to the Marconi Co., he had much to do with the design and equipment of the wireless station at Poldhu, from which the first trans-Atlantic signals were transmitted in December 1901. It was in October 1904, twenty years after his visit to the United States, that it suddenly occurred to him that the Edison effect could be used for rectifying or 'detecting' alternating currents of high frequency, such as those occurring in the circuits of a wireless receiver. After making some confirmatory experiments, Fleming, at the age of fifty-five, applied for a patent for the two-electrode thermionic valve on November 16, 1904. This valve, or diode as we now term it, could be in several forms; but each of these comprised a filament, which could be heated to incandescence, and an insulated metal electrode, both sealed inside an evacuated envelope. Fleming found later that better results in the detection of wireless signals could be obtained when the valve was constructed with a tungsten filament and an insulated copper cylinder surrounding it. Almost concurrently, Wehnelt had noted that if a filament was coated with certain oxides, the emission of electrons was greatly facilitated; hence currents could be obtained with a lower temperature, with corresponding greater sensitiveness and convenience of operation.

The next step in the evolution of the thermionic valve was made by Dr. Lee de Forest, who had been working in the United States on similar lines to Fleming. In 1906, de Forest applied for a patent for

a three-electrode valve as a device for amplifying feeble electric currents, by using a voltage on the grid or intermediate electrode to control the current flowing to the plate or anode. A few months later, the patent was extended to cover the use of the three-electrode valve, or 'audion' as de Forest termed it, as a detector of oscillations in a wireless telegraphy receiver.

After these events, a period of several years elapsed before the thermionic valve, in either its two- or three-electrode form, found any great practical use in the reception of wireless signals. This was partly due to the fact that the technique of the production of high vacua had to be considerably improved before valves could be made and used with anything like a reliable performance; but it was also due to the advanced development of such reliable and sensitive devices as the magnetic and crystal detectors. It was about 1913 before H. J. Round in Britain and other workers in the United States began successfully to apply the valve to wireless reception; and it was really during the First World War that the development of the 'hard' or high-vacuum valve was applied successfully on a large scale to the amplification of audio- and radio-frequency currents in radio reception.

The story was continued in a lecture on "Thermionic Devices from the Development of the Triode up to 1939" by Sir Edward Appleton, who emphasized the fact that de Forest's objective was to obtain a sensitive and controllable detector, for which purpose it was considered essential that there should be some residual gas in the audion. Sir Edward pointed out that in the basic de Forest patent, granted in 1908, a radio-receiving circuit is shown with a grid condenser, and this is deemed to be the invention of what is now called cumulative grid rectification. But it still needed some years of investigation by other workers before the mode of action of the three-electrode valve and its remarkable potentialities were fully recognized. Notable in this phase of development was the work of E. H. Armstrong, who described, in papers published during 1914–15, experiments which did so much to elucidate the function of the triode as a detector and to show the advantage of applying back coupling or retro-action to reinforce the oscillations. He also dealt with the use of the three-electrode valve as a generator of oscillations and for reception on the heterodyne beat principle. Armstrong took advantage of the work of Langmuir in obtaining valves with a very high vacuum, and in consequence he found it necessary to use a high-resistance shunt to the grid condenser in order to control the 'squegging' action, which was sometimes troublesome in the reception of signals with hard valves.

In the meantime, workers in other countries were not idle: following a patent in 1911, von Lieben and Reisz described a soft three-electrode valve containing mercury vapour and its use as a relay or amplifier. The British pioneer workers, H. J. Round and C. S. Franklin, after experimenting with these and other soft valves, appreciated the advantages of the high vacuum and produced some notable valves which achieved an outstanding reputation at the beginning of the First World War. Following the lead when the Americans entered the War in Europe, the French workers under General Ferrié developed the celebrated *R*-type hard valve, which had a cylindrical anode and a spiral grid, the filament being along the axis of both.

By the end of the War, the three-electrode valve, or triode, was really understood; but it was the only valve in common use as a detector, amplifier or generator of high-frequency oscillations. Broadcasting was, in fact, started with the triode, although its limitations were by that time well recognized. To reduce the unwanted inter-electrode coupling between grid and anode, A. W. Hull suggested the insertion of another electrode; and it remained for Round to introduce the screen-grid valve, or tetrode, into practical use in 1926. This brought under consideration the phenomenon of secondary emission from the anode; to reduce this, the insertion of a suppressor grid was proposed by B. D. H. Tellegen, of the Philips organization in Holland, who thus became the inventor of the pentode, a valve which has since become very popular for many purposes.

During the period up to 1939, the two-electrode valve of Fleming had been employed almost solely as a rectifier for alternating currents at power frequency; but near the end of this period, this diode came back into use as a high-frequency detector; and also, by means of a suitable circuit, as an automatic control of the grid bias on the 'variable mu' type of valve, permitting the output from the receiver to be maintained at a sensibly constant level.

In the later portion of his lecture, Sir Edward referred to the use of the thermionic valve as an electrical instrument. While ordinary triodes were found very suitable for use in, for example, E. B. Moullin's valve voltmeter, it required special design to produce an electrometer triode with a low input capacity and a very high insulation resistance for the grid. Such valves have, however, been found very useful for a number of purposes such as the study of the change in the earth's electric field due to lightning flashes. In the period up to 1939, the valve had become a most versatile and important tool in many fields of scientific research, quite apart from its application to radio communication, broadcasting and television.

At the evening session of the meeting at the Institution, Dr. J. Thomson gave a lecture on "Developments in Thermionic Devices since 1939". It was first pointed out that during the period under review the valve has undergone extensive development, not only for radio reception, but also as an amplifier to give a steadily increasing power output in transmitters of all types. But the uses of the valve have now become very widespread; and in analysing the functions of thermionic devices in modern electronic equipment, Dr. Thomson directed attention to the fact that the valve is like an engine, performing the same duties in the electronic machine as the steam or internal combustion engine in the mechanical machine. The unique property of the electronic device is its high speed of operation. This has been exploited by the radio scientist in the development and use of microwave systems; while others are using valves for control and computing mechanisms.

Dr. Thomson made specific reference, with the aid of slides, to the various types of valve now in use for the generation and reception of centimetre-wave frequencies; and gave an explanation of the action of the klystron and its analogous relationship with the travelling-wave tube and the magnetron. He also illustrated the recent developments in the miniature and sub-miniature types of valve, and the

various steps which have been taken to make valves increasingly reliable in operation. Dr. Thomson pointed out that valves are already completely reliable so far as home radio and television sets are concerned; at the same time, he emphasized the fact that the universal application of electronic machinery in offices, factories and in means of transport depends largely upon the reliability of electronic components.

The lecture closed with a brief speculation as to the future. While some may be of the opinion that an electronic valve or tube should never be used if it can be avoided, it is an essential item for high-speed operation. While this speed is still too low for many modern applications, it is likely that in the next half-century this speed of control will be exploited in all fields of activity.

An expression of thanks to the lecturers was made by Mr. C. W. Oatley, chairman of the Radio Section of the Institution, and by Sir Gordon Radley, vice-president of the Institution; Sir Gordon remarked that if Sir Ambrose Fleming could have been present at this jubilee celebration of his invention, he would have been thrilled by the very large family that has sprung from the original and simple diode, and the variety of parts they have played in peace and in war.

R. L. Smith-Rose

PHYSICAL RESEARCH LABORATORY, AHMEDABAD

By Dr. K. R. RAMANATHAN
Director

A RESEARCH laboratory for the study of cosmic rays was started at Ahmedabad in 1947 by a private body called the Karmakshetra Educational Foundation. During the past seven years, with generous assistance from the Ahmedabad Education Society, the Government of Bombay, the Ministry of Scientific Research and the Atomic Energy Commission of India, the Physical Research Laboratory, as it is known, has steadily expanded and widened its scientific interests. The foundation stone of its new building was laid by Sir Chandrashekhar Venkata Raman in 1952 and the building was opened by the Prime Minister, Shri Jawahar Lal Nehru, on April 10, 1954.

The building is in the Gujarat University campus, and facing it are the laboratories of the Ahmedabad Textile Industry's Research Association (see *Nature*, Sept. 25, p. 578) and the Lalbhai Dalpatbhai College of Engineering. In a large field, west of the Laboratory, are a 72-ft. wind tower, radio masts and an experimental hut for ionospheric research. The central wing of the Laboratory runs east to west and has two floors. Nine research rooms on the first floor and five on the ground floor are accommodated in this wing. For cosmic ray measurements, one of the research rooms on the first floor has a specially constructed light roof of aluminium. A conveniently accessible terrace on the first floor is used for observational work on the sun and the sky. The central wing of the Laboratory on the ground floor connects at one end to the library and a seminar room. The staircase is situated at the western end of the central wing, where there is also an experimental area with a high ceiling. This is flanked by the workshop, the dark room, the store and a preparation section. Adjoining the workshop is a yard and a carpentry shop.

The initial research programme of the Laboratory was decided by the interests of its principal scientific workers: Prof. Vikram Sarabhai, who started the Laboratory, is concerned with studying the time variations of cosmic rays and the light they throw on the sources of cosmic rays; the present writer is interested in problems of atmospheric physics such as atmospheric ozone and its distribution, night airglow and problems of the ionosphere. The programme of the Laboratory at the moment comprises an integrated study of the different kinds of radiations which are received on the earth and their geophysical consequences. In order to carry out such a programme satisfactorily, two more Departments, one of Theoretical Physics and another of Radiophysics and Electronics, were added in 1949. With thirty research workers drawn from different parts of the country, the Physical Research Laboratory at Ahmedabad is now an established centre for advanced study and research in experimental and theoretical physics in western India.

Department of Atmospheric Physics. In India the Council of Scientific and Industrial Research has for many years supported a research scheme for the study of atmospheric ozone and the weather, and, with the co-operation of the India Meteorological Department, three ozone-measuring stations have been established at Delhi, Mt. Abu and Veraval. Work done in India has shown that the amount of ozone in low latitudes up to 20° N. is small and nearly constant in different seasons, and is little affected by weather. On the other hand, in European latitudes, the amount of ozone is larger and more variable from day to day. In Indian latitudes north of 20° N., during the months May–November, the amount of ozone continues to be small and steady, but increases markedly in winter. Between December and April there are large quasi-periodic increases of ozone associated with variations of high-level winds in the upper atmosphere. Studies of the vertical distribution of ozone in the atmosphere that have been made over Delhi, Mt. Abu, Poona and Kodaikanal have established that the tropical troposphere which extends to nearly ten miles above the ground contains only small quantities of ozone, but that, as one goes to higher latitudes, more and more ozone comes down to lower levels. The change from the tropical type of ozone distribution to the extra-tropical type appears to take place in the region of high-level jet streams of westerly upper winds. The study of the correlated variations of atmospheric ozone at a number of places promises to throw light on the general circulation of the atmosphere at levels not otherwise easily accessible to observation.

An important discovery has resulted from careful ozone measurements made during moonlight. It has been shown that there is a daily variation in the amount of ozone in Indian latitudes, there being an excess of ozone during the night.

Besides the work on the ozone content of the atmosphere, a large number of radiosonde ascents have been made at Ahmedabad to study the daily and the day-to-day variations of temperature and humidity in the upper atmosphere. They have considerably increased our knowledge of the upper atmosphere over north-west India, and have also been of help in interpreting the corresponding variations of cosmic ray intensities.

Photo. by J. M. Shah

Physical Research Laboratory, Ahmedabad

Studies of twilight sky intensities and polarizations have been undertaken using a photo-multiplier. Measurements on the brightness of the sky in different narrow spectral bands have been carried out at Mt. Abu from sunset to a time when full night conditions have set in. Observations show that, after the sun has gone down 5°–6° below the horizon, there is very much more light coming from the sky than can be explained by the primary scattering of sunlight by the molecules of the upper atmosphere. Part of this is undoubtedly due to night air-glow, but there are possibly other causes, such as scattering by meteoric dust in the upper atmosphere. The problem is under investigation.

Cosmic Ray Department. Under Prof. Sarabhai, the Cosmic Ray Department has established continuous recording stations at Ahmedabad, Kodaikanal and Trivandrum. The second and third, almost at the magnetic equator, represent a mountain and a sea-level station, respectively. Observations collected over three years have shown clearly the value of directional studies with Geiger counter telescopes, with which the daily variations are larger and capable of more unambiguous interpretation than with ionization chambers.

In interpreting the experimental results, there are several factors which have to be taken into account: the atmospheric pressure, the heights of levels where cosmic-ray mesons are created, and the atmospheric temperatures near these levels. Work done at the Laboratory indicates that atmospheric mass absorption is the only important meteorological factor so far as the daily variation of the meson intensity is concerned, and its influence can be corrected for by using the known variations of atmospheric pressure. The geomagnetic effect being small, it is possible to attribute the daily variation of meson intensity, corrected for barometric pressure, to an anisotropy of the primary cosmic rays. For the daily variations of the soft electronic component and the atmospheric shower intensity there are, however, more complicated relationships with meteorological factors. These involve, besides the total mass of the air column, its vertical distribution, depending on atmospheric temperatures at different levels.

The pressure-corrected daily variation of meson intensity, which can be attributed to the anisotropy of cosmic rays, has a maximum in the forenoon at low latitudes. The dependence of this maximum on local solar time has been interpreted as indicating that the anisotropy is under solar control. This is also supported by an analysis done by Sarabhai and Kane of the published cosmic-ray data of the Carnegie Institution stations. The analysis has led to the discovery that the daily variation of the meson intensity, corrected for pressure, undergoes large changes of world-wide character, and that these changes are connected with those in solar activity. As the simplest explanation, it has therefore been suggested that a small portion of the primary cosmic radiation originates in the sun. Sarabhai and Kane have also directed attention to a geomagnetic explanation for the difference in the daily variation studied at different latitudes and with apparatus pointing to different directions.

A comprehensive programme is now in progress at the Laboratory for developing an optimum technique for the study of the anisotropy of the primary radiation.

Department of Theoretical Physics. This Department, which was first under Dr. A. B. Bhatia and is now under Dr. Vachaspati, is concerned with fundamental theory and the problems of nuclear structure. Dr. Vachaspati and his colleagues have been interested in the question of nuclear radii and have recently suggested, on the basis of electron scattering and Coulomb energy data, that the nucleus might have some negative charge at its centre along with positive charge outside. Calculations are also being done on the scattering of π-mesons by nuclei, energy-levels of μ-mesonic atoms, alpha-decay lifetimes and some aspects of field theory. The Department gives regular courses in theoretical physics to post-graduate students.

Department of Radiophysics and Electronics. Work in this Department, which is now under Dr. U. D. Desai, is directed towards the systematic recording and analysis of the characteristics of the ionosphere at Ahmedabad with an automatic multi-frequency recorder. Hourly records of reflexions of radio waves

have been obtained since February 1953, and monthly summaries of the data are published in the *Journal of Scientific and Industrial Research*. At present, Ahmedabad is one of the three stations in India at which round-the-clock observations of the ionosphere are being made.

Besides the main regions, E, F_1 and F_2, of the ionosphere, two intermediate layers between E and F_1 have been found to be regularly recorded, and these are being studied. A comparative study is also being made of the critical frequencies and heights of F_2 reflexion at different latitudes in India, and also the effect of magnetic storms and solar flares on the F_2 region. In addition, the true heights and thicknesses of the F_1 and F_2 regions, and the total electron content in a vertical column of the atmosphere up to the height of maximum electron density, are being examined. A radio pulse transmitter, aerials and recording receiver have been built for studying winds in the ionosphere on the lines of Mitra's method.

PERMANENT MAGNET ASSOCIATION

CENTRAL RESEARCH LABORATORY

THE research activities of the Permanent Magnet Association were conducted for many years by co-operative investigations carried out in the works laboratories of its members. The technical collaboration so fostered has many advantages and such work still continues; but in 1941 centralized research, more removed from the distractions of production problems, was commenced with the equipment housed temporarily in the Physics Department of the University of Sheffield, by courtesy of the University authorities.

In 1946 it became possible to proceed with the building of the first story of a laboratory in Brown Street, Sheffield. This building, opened in 1946, gave facilities for pilot manufacture and heat treatment of magnet castings. Physical, chemical and metallographic laboratories were included, and also a workshop for apparatus and instrument construction.

The original plans have recently been completed by the addition of a second story, and on November 8 representatives of the technical Press, of local industrial concerns and of scientific establishments were invited to view the laboratories and to see some of the work now in progress. The new story includes a heat-treatment laboratory, a library and conference room and also gives additional office and storage space. These extensions, in conjunction with the e-arrangement of the older laboratories, now give a rationalized lay-out of the various sections.

The laboratory is approved by the Department of Scientific and Industrial Research but is not grant-aided, being supported wholly by the manufacturing firms who are members of the Association. The director is not only responsible for the work of the Central Laboratory, but also keeps in close touch with the research activities in the laboratories of the members, thus promoting the continuation of that technical collaboration which has been found fruitful throughout the history of the Association. In these circumstances it would be invidious to distinguish between the technical progress of the Central Research Laboratory and of the Association as a whole.

The principal activity of the Laboratory lies in the development of new permanent-magnet materials and the improvement of the properties and of the economy of processing of the existing alloys. The high energy ($BH_{max.}$) of modern magnet alloys is only obtainable by the use of large percentages of expensive metals, and so the achievement of maximum properties with minimum consumption of alloy is a constant objective. In 1945 it was possible to introduce 'Alcomax II' with average $BH_{max.}$ 4·5 megagauss-oersted and coercivity 575 oersted. Work on a wide range of additions to the basic alloy led in 1948 to the discovery of the beneficial effects of niobium in small amounts. There followed the introduction of 'Alcomax III' with $BH_{max.}$ 5·0 megagauss-oersted, coercivity 670 oersted, and of 'Alcomax IV' with $BH_{max.}$ 4·5 megagauss-oersted, coercivity 750 oersted. Shortly afterwards it was predicted on theoretical grounds that similar anisotropic alloys with a common crystal axis instead of random orientation should have markedly improved properties. Considerable experimental work led in 1952 to laboratory production of 'Columax', with remanence 13,000–14,000 gauss, $BH_{max.}$ more than 8·5 megagauss-oersted, and coercivity 750–850 oersted. The production of the structure necessary for such properties requires that the solidification of the alloy should take place progressively from one face of the casting. A mould which is chilled on one face and heated on other faces to temperatures approaching the solidus temperature of the alloy is necessary. The study of the thermal conditions for a completely columnar structure and of practical means of obtaining columnar castings is an important part of the current work. The maximum properties obtained in the laboratory cannot yet be realized in quantity production, although marked improvement on random crystal material is possible.

The metallography of 'Alcomax' alloys is not fully understood, but the diagnosis of faults in composition or heat treatment by microscopic observation of the incipient development of two-phase structures has been of practical utility. Some remarkable macroscopic structures can be seen by the polishing and etching of 'Columax' specimens, which demonstrate well the effect of crystal orientation on the reflexion of light from an etched surface.

High-energy permanent magnets of complex composition have led to secondary problems. Magnets tend to smaller and smaller sizes, and the measurement of the normal B–H curve criteria on small pieces has required the development of modified apparatus and methods. New methods of chemical analysis have been necessary for alloys of increasing complexity. Electrolytic separation and the use of absorptiometric and chromatographic techniques have been found necessary. Here also the collaboration with works laboratories has been valuable, and the analytical methods standardized by the Association have been approved and published by the British Standards Institution.

With the support of the Electrical Research Association, investigations are proceeding on the stability of magnetization under extremes of temperature. Very little knowledge existed until recently on the effect of sub-zero temperatures, although there is now a definite practical interest down to −70° C. The nickel–aluminium magnet alloys are very resistant to demagnetization by heating, and so the observation in 'Alcomax' magnets of losses of magnetization to the extent of 1–4 per cent due to

cooling to about −70° C. was surprising. It has been found that the coercivity of 'Alcomax' after normal heat treatment decreases reversibly with decreasing temperature between 0° and −180° C., but that this change can be reduced by modifications to the heat treatment. Any stabilization or ageing process which brings the working values of B and H for the magnet within the main hysteresis loop also eliminates the loss due to cooling.

Hysteresis motors are coming into general use as components of gyro and servo systems. The rotors of these motors require a hysteretic material of the permanent magnet type; but the operating conditions are not well defined and there have been few measurements made with non-saturating magnetic fields or of rotating rather than alternating hysteresis. It has become customary to use for these rotors one of the magnet steels, frequently in a metallurgical condition other than fully hardened. A large programme of measurements is in hand to provide a body of design data for this application and to check the optimum magnetic and metallurgical conditions for maximum utilization of material.

Fundamental physical research on high-coercivity materials has always occupied an important place in the work of the Central Research Laboratory of the Association. Measurements of magnetostriction and of anisotropy coefficients on 'Alcomax' alloys and their interpretation in the light of current ferromagnetic theory have been the basis of a series of published papers. This work, in conjunction with work elsewhere by X-ray and electron diffraction techniques and the electron microscope, has led to a better understanding of the origin of the preferred-domain orientation and high coercivity which is the basis of the nickel–aluminium–cobalt–iron alloys used for high-energy permanent magnets.

CHEMISTRY OF MUSCLE CONTRACTION

Contraction of Muscle without Fission of Adenosine Triphosphate or Creatine Phosphate

As Hill[1] has pointed out, it still remains to be proved that adenosine triphosphate is the immediate source of energy in the contracting muscle. The analytical methods now available for determining the individual phosphate fractions of animal tissues have made it possible to re-examine directly the relation between contraction and breakdown of adenosine triphosphate. Experiments are here reported which suggest that muscle can in fact do work under certain well-defined conditions without the decomposition of an energetically equivalent amount of adenosine triphosphate or creatine phosphate.

The crucial experiments were carried out on a slow muscle, the rectus abdominis of the frog, *Rana temporaria*, at 0° C. A slow muscle and a low temperature were chosen in order to reduce the rate of chemical processes. Pairs of muscles from the same animal were used in each experiment. One, left and right alternately, was stimulated while the second served as control. Otherwise both were treated in the same way. The muscles were stimulated either electrically, or by immersion in isotonic 0·765 per cent potassium chloride solution, or by immersion in 0·5 per cent caffeine–Ringer solution. The work done during contraction was calculated from the kymographic record[2]. After the attainment of contraction, the muscle and the control were quickly placed in liquid nitrogen. No contraction occurred in the controls on freezing as the muscles were thin and cold.

To determine the phosphate fractions, the frozen tissue was ground in a cold mortar and trichloroacetic acid solution was added to the frozen muscle powder. The mixture was allowed to melt at 0° C. and centrifuged. Creatine phosphate was determined in the supernatant according to Eggleton and Eggleton[3]. Two more samples were chromatographed on paper by a modification[3] of the methods of Eggleston and Hems[4] and Krebs and Hems[5] for the determination of the following six fractions: (*a*) creatine phosphate, (*b*) inorganic phosphate, (*c*) adenosine triphosphate, (*d*) adenosine diphosphate, (*e*) an 'unknown' fraction ('Dritte Fraktion' of Fleckenstein and Janke[6]), and (*f*) the total acid-soluble organic phosphate minus creatine phosphate. Recovery of added creatine phosphate, adenosine tri- or di-phosphate was quantitative[7]. The fractions $c + d + e$ form about two-thirds of f. The techniques are described in full elsewhere[2,6,8].

In the case of the potassium contracture, no significant change of adenosine tri- or di-phosphate occurred at 0° C. or 20° C., but the amounts of creatine phosphate decreased (Table 1). These findings are in agreement with the assumption that adenosine triphosphate decomposes but is almost at once regenerated by the transfer of phosphate from creatine phosphate to adenosine diphosphate. They are not in agreement with Bendall's[9] view that the

Table 1. Changes in Phosphate-containing Compounds as a Result of a Single Contraction at 0° C. caused by Immersion for 45 sec. in 0·765 per cent Potassium Chloride Solution

(All phosphorus estimations on each sample were carried out in duplicate and comparisons were made between the left and right side of the rectus abdominis from the same frog (*Rana temporaria*). The mean difference was obtained from the differences between the test and control of each pair of experiments. The muscles were cut off the support and frozen in liquid nitrogen. For further details see ref. 6). The absolute amounts and ratios of the various fractions vary with the time of year, so the controls in Tables 1–4 are not directly comparable with each other

Notes	*a* Creatine phosphate (μmol./gm.)	(*a* + *b*) Creatine phosphate + the inorganic phosphorus (μmol. P/gm.)	Fraction *c* Adenosine triphosphate (μmol./gm.)	*d* Adenosine diphosphate (μmol./gm.)	*e* An unknown fraction ('Dritte', ref. 6) (μmol. P/gm.)	Work done by the muscle (gm. cm./gm.)
8 pairs { Test		18·5	1·80	1·44	2·10	136 ± 8
8 pairs { Control		18·0	1·85	1·53	2·59	
4 pairs { Test	5·99					81 ± 5
4 pairs { Control	7·44					
Mean difference	− 1·45	− 0·5	− 0·05	− 0·09	− 0·49	
Standard error of mean difference	± 0·25	± 0·5	± 0·02	± 0·08	± 0·16	

Table 2. Changes in Phosphate-containing Compounds as a result of a Single Contraction at 20° or 0° C. produced by 2½ min. Immersion in ¹ per cent Caffeine–Ringer Solution
(Other details as in Table 1. For further details see ref. 8)

Notes	Fraction *a* Creatine phosphate (μmol./gm.)	Fraction (*a* + *b*) Creatine phosphate + the inorganic phosphorus (μmol. P/gm.)	Fraction *c* Adenosine triphosphate (μmol./gm.)	Fraction *d* Adenosine diphosphate (μmol./gm.)	Fraction *e* An unknown fraction ('Dritte', ref. 6) (μmol. P/gm.)	Work done by the muscle (gm. cm./gm.)
20° C.						
6 pairs Test		19·9	1·20	1·17	0·91	162 ± 23
6 pairs Control		16·3	2·13	1·05	1·68	—
6 pairs Test	0·57					154 ± 19
6 pairs Control	6·68					—
Mean difference	− 6·11	+ 3·62	− 0·93	+ 0·12	− 0·77	
Standard error of mean difference	± 0·37	± 0·31	± 0·12	± 0·068	± 0·26	
0° C.						
6 pairs Test		17·4	2·17	0·92	1·66	109 ± 15
6 pairs Control		17·3	2·21	1·03	1·77	—
5 pairs Test	2·65					82 ± 4·1
5 pairs Control	6·36					—
Mean difference	− 3·71	+ 0·1	− 0·04	− 0·11	− 0·11	
Standard error of mean difference	± 0·60	± 0·87	± 0·09	± 0·06	± 0·26	

Table 3. Changes in Phosphate-containing Compounds as a result of a Single Contraction at 20° or 0° C. caused by 1·0–1·2 sec. Electric Stimulation
(The muscles were frozen *in situ* on the support. Other details as in Table 1. For further details see ref. 2)

Notes	Fraction *a* Creatine phosphate (μmol./gm.)	Fraction (*a* + *b*) Creatine phosphate + the inorganic phosphorus (μmol. P/gm.)	Fraction *c* Adenosine triphosphate (μmol./gm.)	Fraction *d* Adenosine diphosphate (μmol./gm.)	Fraction *e* An unknown fraction ('Dritte', ref. 6) (μmol. P/gm.)	Fraction *f* Total organic phosphorus − the creatine phosphate (μmol. P/gm.)	Work done by the muscle (gm. cm./gm.)
20° C.							
12 pairs Test*	11·25	24·93	2·77	0·87	1·14	15·36	190 ± 11·1
12 pairs Control	13·32	25·70	2·77	0·91	1·20	16·53	[47·7 ± 4·4]†
Mean difference	− 2·07	− 0·77	0·00	− 0·04	− 0·06	− 1·17	
Standard error of mean difference	± 0·38	± 0·51	± 0·053	± 0·049	± 0·14	± 0·33	
0° C.							
20 pairs Test	11·46	22·21	2·82	0·71	0·96	15·50	125·3 ± 20·8
20 pairs Control	11·14	21·96	2·80	0·70	0·93	15·70	0 ± 0·0
Mean difference	+ 0·32	+ 0·25	+ 0·02	+ 0·01	+ 0·03	− 0·20	
Standard error of mean difference	± 0·20	± 0·39	± 0·040	± 0·032	± 0·073	± 0·27	

* In this series the total acid-soluble phosphorus in the test muscles was less than in the control muscles. Fraction (*a* + *b*) represented 61·9 per cent of the acid-soluble phosphorus in the test series and 60·9 per cent in the control series. For further details see ref. 2.
† The control muscles contracted somewhat on freezing. This did not occur with control muscles at 0° C.

Table 4. Changes in Phosphate-containing Compounds as a result of a Single Contraction at 0° caused by 1·3–3·5 sec. Electric Stimulation after 20 min. Pretreatment with 5×10^{-4} *M* 2 : 4-Dinitrophenol
(The muscles were frozen *in situ* on the support. Other details as in Table 1)

Notes	Fraction *a* Creatine phosphate (μmol./gm.)	Fraction (*a* + *b*) Creatine phosphate + the inorganic phosphate (μmol. P/gm.)	Fraction *c* Adenosine triphosphate (μmol./gm.)	Fraction *d* Adenosine diphosphate (μmol./gm.)	Fraction *e* An unknown fraction ('Dritte', ref. 6) (μmol. P/gm.)	Fraction *f* Total organic phosphorus–the creatine phosphate (μmol. P/gm.)	Workdone by the muscle (gm. cm./gm.)
12 pairs Test	0·58	21·18	1·76	0·91	0·31	12·44	109·8 ± 4·7
12 pairs Control	0·62	20·77	1·75	0·87	0·29	13·14	0 ± 0·0
Mean difference	− 0·04	+ 0·41	+ 0·01	+0·04	0·02	− 0·70	
Standard error of mean difference	± 0·100	± 0·45	± 0·048	± 0·040	± 0·073	± 0·306	

adenosine triphosphate-level must fall during contraction.

In the case of the caffeine contracture, a decrease of adenosine triphosphate and creatine phosphate and an increase in adenosine diphosphate and inorganic phosphate occurred at 20° C. At 0° C. the results were similar to those with potassium chloride (Table 2). The results show that the methods used were capable of detecting changes in the concentrations of these compounds.

In the case of contracture due to electrical stimuli (12 stimuli per sec. by condenser discharge and direct stimulation of the muscle), no change in adenosine tri- and di-phosphate took place at 20° C., whereas the concentration of creatine phosphate fell (Table 3). At 0° C. no adenosine tri- or di-phosphate or creatine phosphate disappeared; but there was a decrease in fraction (*f*) and an increase in inorganic phosphate. This was sufficient to account for the work done on the assumption that the inorganic phosphate was derived from an 'energy-rich' phosphate, and that the efficiency approached 100 per cent. The nature of the organic phosphate that released inorganic phosphate under these conditions is unknown. It is being investigated. It should be pointed out that the period of contraction on electrical stimulation was 0·9–1·2 sec. and that creatine phosphate breakdown occurred after electrical stimulation for several seconds even at 0° C. When potassium chloride or caffeine was the stimulant a

much longer period of incubation of 15 sec. or 2½ min. was required because, *inter alia*, of the relatively slow penetration of these agents.

These experiments support the view that muscular contraction can occur without decomposition of adenosine triphosphate or creatine phosphate[2]. However, the expected decrease in the concentration of creatine phosphate present, assuming 100 per cent efficiency, was only 3 per cent of the total creatine phosphate present. Statistical analysis shows that the chance that this decrease occurred but had escaped detection was only 28 per 1,000. Nevertheless, it was thought desirable to find conditions where the expected change in the concentration of creatine phosphate would be greater on a percentage basis. Pre-incubation for 20 min. at 20° C. with 5×10^{-4} *M* 2 : 4-dinitrophenol produced such conditions. This treatment reduced the creatine phosphate content of the tissue from about 11 μmoles per gm. to 0·6 μmoles per gm., but the muscles still contracted vigorously even at 0° C. (though they were unable to relax). In this material the expected decrease in creatine phosphate concentration was 50 per cent or more; yet there was again no significant change in the adenosine tri- and di-phosphate and creatine phosphate fractions, while the fraction *f* decreased and the inorganic phosphate increased (Table 4). It should be noted that the low level of creatine phosphate rendered any rephosphorylation of adenosine diphosphate from this source thermodynamically highly improbable.

To exclude the possibility that creatine phosphate or adenosine triphosphate was resynthesized at the expense of respiration during the duration of the experiments (1·3–3·5 sec.), the rate of recovery of creatine phosphate, after electrical stimulation for 1 min., was measured. At best, resynthesis was thirty times lower than required for the non-disappearance of creatine phosphate. A similar large discrepancy was obtained from calculations based on the rates of respiration of stimulated muscle and maximum possible values for the efficiency of oxidative phosphorylation.

The results show that, though a breakdown of creatine phosphate (and under some conditions even of adenosine triphosphate) can be observed after contractions lasting several seconds or more produced by electrical stimulation, potassium chloride or caffeine, such a breakdown did not occur in the rapid contractions at 0° C.

In conclusion, it may be said on the basis of the electrical experiments at 0° C., especially those in the presence of dinitrophenol, that muscle has been shown to do work without the fission of energetically equivalent quantities of adenosine triphosphate or creatine phosphate. Inorganic phosphate was, however, liberated during contraction, from an unidentified precursor in just sufficient quantities to supply the required energy, provided the phosphate undergoing fission was 'energy-rich'.

It follows that there is a source of energy in living muscle which either can synthesize adenosine triphosphate from the diphosphate at a rapid rate (like creatine phosphate), or which is closer to the process of contraction than the breakdown of adenosine triphosphate. Whether this source is the 'phosphate-bond energy' of an unidentified compound or an entirely different kind of source such as ionic concentration gradients[10] remains to be investigated.

A full account of this work will be published elsewhere.

In the following communication, Dr. W. F. H. M. Mommaerts presents results obtained independently which are concordant with those presented here and elsewhere[2,6,8].

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Is Adenosine Triphosphate broken down during a Single Muscle Twitch?

The widespread assumption that muscular contraction is caused by enzymatic hydrolysis of adenosine triphosphate is based on two types of not entirely direct evidence[1–3]. On one hand, biochemical research has demonstrated that metabolic processes such as respiration and glycolysis, which indirectly support muscular activity, do so by virtue of the synthesis of adenosine triphosphate. On the other hand, various interactions between adenosine triphosphate and muscle proteins have been described, culminating in the contraction (induced by adenosine triphosphate) of actomyosin threads and extracted muscle fibres discovered by Szent-Györgyi. Yet a direct demonstration of the role of adenosine triphosphate in living muscle has not been given, notwithstanding A. V. Hill's[4] call for such a straightforward approach.

In the present work, of which a full account will be submitted to the *American Journal of Physiology*, an attempt has been made to demonstrate the breakdown of adenosine triphosphate and of phosphocreatine during the course of a single twitch. Experiments were carried out on symmetrical pairs of leg muscles of the turtle, *Pseudemys elegans*, one of which was stimulated, while the other acted as the control. At a chosen moment, early or late in the contraction, the muscles were suddenly immersed in liquid propane, cooled to −185° C., by means of a mechanical device effecting this immersion in about 6 m.sec., the twitch itself lasting 2–8 sec. at low temperature. The muscles were loaded so as to perform approximately maximal work and their movements were recorded on a revolving drum. In all instances, the cooling procedure caused immediate stopping of the muscle at the moment of immersion, whereas temperature measurements inside muscles, with a thermocouple and cathode ray oscillograph, showed precipitous cooling without delay.

It was anticipated that if the contraction of muscle were caused by a fission of adenosine triphosphate or phosphocreatine, this fission would amount to 0·3–

0·5 μmol. per gm. of tissue[2,5]. In designing the analytical procedures, it was held that it would be difficult to prove or disprove the occurrence of such a degree of breakdown of adenosine triphosphate or phosphocreatine by direct determination of these substances, since they occur in amounts which are large in proportion to the change anticipated to take place in one twitch. It was decided, instead, to determine the possible breakdown products, adenosine di- and mono-phosphate and creatine. In addition, creatinine was also determined, although its formation would be rather improbable; finally, pyruvate was determined to cover the possibility of a rephosphorylation of adenosine diphosphate by phosphopyruvate formed, for example, from phosphoglycerate. The analyses of creatine and creatinine were carried out colorimetrically, by the Voges–Proskauer and the Jaffe reactions, respectively. All the other analyses were carried out by differential enzymatic spectrophotometry: adenosine monophosphate with adenylate deaminase; pyruvate with lactic dehydrogenase and reduced diphosphopyridine nucleotide; adenosine diphosphate by phosphorylation with phosphopyruvate and pyruvate phosphokinase, followed by assay of the pyruvate so formed. The results of assaying inosinic acid as a possible end-product (measured with 5-nucleotidase, nucleoside phosphorylase and xanthine oxidase) are still subject to some experimental uncertainty, but are in all probability negative.

In Table 1, results of these analyses are collected for various times throughout the contraction and the relaxation phases. It is seen that in no case was any significant change found in the amount of adenosine mono- or di-phosphate or creatine. Creatinine and pyruvate were likewise unchanged. Fluctuations of the individual pairs—always within 0·1 μmol. and usually within 0·05 μmol.—are entirely random, and a systematic variation of the expected magnitude is therefore excluded.

It may be said with certainty that a breakdown of adenosine triphosphate or phosphocreatine could not have been reversed by metabolism, since both aerobic and anaerobic recovery are known to occur only well after a single twitch. The experiments described were carried out anaerobically, in a mixture of nitrogen and carbon dioxide or in helium; a few aerobic experiments gave the same result.

Table 1. Change in Concentration of the Main Reaction Products (in μmol. per gm.) during the Course of Muscle Twitch

	△ ADP	△ AMP	△ Creatine
Early contraction	− 0·07		+ 0·07
	0·00		
	+ 0·04	0·00	+ 0·01
	− 0·07		
	+ 0·08		− 0·03
		− 0·04	+ 0·04
Ascending phase	− 0·08		+ 0·06
		0·00	− 0·03
	− 0·03	0·00	0·00
	− 0·06	+ 0·01	+ 0·07
		− 0·01	
	− 0·02		− 0·03
	+ 0·03		
Peak of contraction	0·00		− 0·05
	+ 0·02	0·00	0·00
	− 0·01	− 0·03	+ 0·07
	− 0·02	0·00	− 0·10
			− 0·09
	+ 0·01		+ 0·03
	+ 0·05	0·00	− 0·03
Relaxation	− 0·02	0·00	0·00
	+ 0·03	0·00	− 0·09
			+ 0·10
	− 0·19		0·00
Mean change during contraction phase	− 0·01	0·00	+ 0·01
Mean change during relaxation phase	− 0·01	0·00	− 0·01

Since we are at present investigating the possible role of other nucleotides, it is considered premature to discuss in full the possible implications of these results for our understanding of muscle. However, the possibility of a new "Revolution in Muscle Physiology"[6] is clearly discernible.

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OBITUARY

Dr. R. S. Wilson

Robert Sharp Wilson, Fellow of the Research School of Physical Sciences in the Australian National University, died in Canberra on October 4 at the age of thirty-eight. He was a leading member of the team working under Prof. M. L. Oliphant on the design of a 10-GeV. proton synchrotron.

Born in Lancashire, Wilson graduated at Cambridge in 1938 and continued with research in nuclear physics at Liverpool under Sir James Chadwick. Throughout the war years he was a scientific officer at the Telecommunications Research Establishment, Malvern. At the beginning he worked on the development and use of radar in night-fighters for air interception. Later he became a valued member of the Radio Countermeasures Division engaged on denying to the enemy much of the advantage of his radar and radio systems. This work had a significant effect in reducing Allied losses, both in air operations over Germany and in the invasion of Europe.

In 1945 Wilson joined Prof. Oliphant at Birmingham, where he was responsible for the radio-frequency system of the 60-in. cyclotron. While there he completed his thesis for Ph.D. (Liverpool), making an analysis of the theory of cyclotrons. In 1951 he was the first Fellow to be appointed in the Research School of Physical Sciences of the newly established Australian National University. Here he investigated the possibilities of various radio-frequency systems for the several high-energy particle accelerators that were under consideration, and at the time of his death was working on the system chosen for the 10-GeV. air-cored synchrotron. He visited laboratories in the United States and Britain in 1953 in order to study the latest developments in synchrotron design and report on the possible value to the Canberra machine of the revolutionary strong-focusing system.

Wilson was much valued for his clear thinking on policy and his fundamental approach to the physics of the problems with which both he and his colleagues were associated. He lived up to and helped to spread the best traditions of physics as taught in Britain.

Dr. Wilson has left a wife and three sons.

J. W. Blamey

NEWS and VIEWS

Australian Atomic Energy Commission : Prof. C. N. Watson-Munro

THE Australian Atomic Energy Commission has announced the appointment of Prof. C. N. Watson-Munro, professor of physics in Victoria University College, New Zealand, to the position of Chief of Research and Development. The Australian Government has already approved a programme of construction of a nuclear research reactor and research laboratories in New South Wales, and these will be the first objective of the scientific team to be built up under the direction of Prof. Watson-Munro. Prof. Watson-Munro, who is thirty-nine years of age, was born in New Zealand and educated at Victoria University College, Wellington. During 1936–39 he was employed by the New Zealand Department of Scientific and Industrial Research as a geophysicist ; he published a paper on a reconnaissance magnetic survey of the New Zealand thermal regions (now being used for the production of heavy water) and one on a radioactive survey of New Zealand rocks and soils. In 1939 he transferred to radar work, and after a year in 1941 with the American radar team at the Massachusetts Institute of Technology, he became director of the New Zealand Radar Development Laboratory. In addition to meeting the needs of the New Zealand Armed Forces, this Laboratory supplied the Royal Navy with thirty radar sets and the U.S. Forces in the Pacific with ten mobile radar sets. Prof. Watson-Munro went into the Pacific war theatre with the sets supplied to the United States and was given the honorary rank of major.

In mid-1944, Prof. Watson-Munro led a group of New Zealand scientists sent to join the British–Canadian group of atomic energy workers in Montreal and at Chalk River. He took a leading part in the design and construction of the first Canadian heavy-water pile (ZEEP) and was responsible for the control equipment. In 1945 Prof. Watson-Munro went to England and was in charge of the design and construction of the first pile in the United Kingdom (GLEEP). He returned to New Zealand in 1948 to take over the position of deputy secretary of the Department of Scientific and Industrial Research in charge of all the physical, geophysical and engineering activities of that Department. He was also scientific adviser to the Armed Forces and attended two meetings of the Commonwealth Defence Scientific Advisory Committee. He took up his present appointment to the chair of physics at Victoria University College in 1951.

Division of Fisheries, C.S.I.R.O., Australia : Dr. H. Thompson

DR. HAROLD THOMPSON, the founder and for seventeen years the chief of the Division of Fisheries of the Commonwealth Scientific and Industrial Research Organization, Australia, is to retire shortly at the age of sixty-four. Dr. Thompson is a Scot, born in Aberdeen in 1890, and from 1920, after service in the army during the First World War, he was for ten years scientific adviser of the Fishery Board for Scotland, gaining a D.Sc. of the University of Aberdeen in 1927 for his work on the natural fluctuations in the stocks of haddock. In 1930 he became director of fishery research in Newfoundland, a post which he left six years later to take up his present appointment in Australia. Although the Second World War halted many of the advances which he had planned, Dr. Thompson gave valuable service during this period as comptroller of fisheries in the Department of War Organization of Industry. The programme of research and exploration was resumed in 1946 and has continued with much benefit to the Australian fisheries and world fisheries science. The Division has contributed considerably to the establishment and extension of the whale, tuna, crayfish and shark fisheries ; it has shown the need to relax the fishing pressure on certain kinds of fish, while indicating others that might be used to take their place, and it has made considerable strides in the study of the movement and fertility of Australian sea-water masses on which all marine life depends. Dr. Thompson leaves behind him a large body of knowledge of Australian fisheries and a thriving Division to carry on his work.

Industrial Power from Nuclear Energy

A FRIDAY Evening Discourse was delivered at the Royal Institution, London, on December 3 by Sir Christopher Hinton, deputy controller of atomic energy (production), Ministry of Supply, his subject being "Industrial Power from Nuclear Energy". In his address, Sir Christopher explained that, whereas in the burning of hydrocarbon fuels to obtain heat only the extra-nuclear electrons of the atoms are disturbed, the production of heat from atomic fuels involves nuclear transformations, the most easily performed such transformation being nuclear fission. The only naturally occurring element which can be induced to carry out a chain reaction, whereby neutrons emitted from the fission of a nucleus cause fission in further nuclei, is the 235 isotope of uranium, and this process is used in the atomic pile, in which most of the large quantity of energy evolved is in the form of heat. The uranium pile reaction forms the artificial element plutonium, which is bred by neutron irradiation of the uranium-238 isotope and subsequent radioactive decay, and is also fissionable. To effect a balance between the neutrons used for fission and the neutrons used for breeding plutonium, a moderator is used, which slows down the emitted fast neutrons, making them more readily available to carry out the fission process. The graphite-moderated air-cooled piles at Windscale are not designed to utilize the heat evolved, the waste heat being ejected up the stacks ; but the graphite-moderated carbon dioxide-cooled piles at Calder Hall will produce heat of high enough grade to raise steam suitable for electricity generation. A further type of reactor, called a breeder reactor, is envisaged, which will use enriched fuel and fast neutrons and which, besides producing useful heat, may produce fissile material in excess of its fuel consumption. Although the estimated cost of nuclear electricity is some 50 per cent above the cost of electricity produced by the most modern power station, Sir Christopher considers that the real cost should fall as techniques improve and a reasonable price is quoted for the fissile material bred in the piles. Thus he envisages the future programme as consisting of a chain of thermal reactors producing plutonium as a by-product, followed by the use of this plutonium in the fast reactor or breeder pile.

University College, London: Restoration of War-damaged Buildings

On November 30 a celebration was held in University College, London, to mark the restoration of the original College buildings in the main quadrangle, which were destroyed by enemy action during 1940–41. The present visitor to the College will find it difficult to realize the degree of damage which was suffered, so remarkable is the recovery that has since been made. Nearly fifty thousand square feet were totally destroyed and another fifty thousand were almost completely gutted by fire. The destruction included all the historic buildings of the College and much else, including the Physics Laboratory and the Great Hall. Fortunately, the College has been able to extend its site between Gower Street and Gordon Square to an area of twelve acres, and this has already given opportunities for the beginning of long-delayed expansions. The first block of the new Physics Building, a handsome and effective series of laboratories, has been completed. Industry has contributed to a preliminary stage in the development of the Chemistry Department. The College authorities feel that the most pressing need of the moment is for a new Great Hall, since at present the only assembly room is the Gustave Tuck Theatre, which, though a beautiful building, houses less than two hundred. As the provost of the College, Dr. B. Ifor Evans, pointed out at the celebration, University College, London, has a very worthy place in the history of university education in Great Britain. Founded in 1828 as a centre for university instruction and research without any restrictions of race or religious faith, it has grown during the past century and a quarter in a notable way until its present student population is three thousand five hundred. Though the standing of a university institution does not rest solely on its architecture and setting, it is worthy of notice that the concepts of the College's original founders were matched by those of the architect, William Wilkins. He provided the College on its then newly acquired site in Gower Street with what John Summerson has described as its "tremendously grand portico raised on a great podium with steps"; to this were added later the Flaxman Gallery and the Donaldson Library, and a quadrangle was formed with the Slade School, the Bartlett School of Architecture and buildings for the Faculty of Arts and the School of Egyptology.

Advisory Committee on the Protection of Birds

The Home Secretary has appointed the following to be members of the Advisory Committee on the Protection of Birds for England and Wales: Sir A. Landsborough Thomson (*chairman*), Miss P. Barclay-Smith, Mr. P. E. Brown, Colonel R. S. Clarke, Mr. J. M. Craster, Mr. James Fisher, Mr. William Foster, Mr. Nigel Laing, Captain S. T. A. Livingstone-Learmonth, Mr. G. R. Mountfort, Mr. E. M. Nicholson, Major-General A. G. O'Carroll-Scott, Mr. Peter Scott and Mr. H. N. Southern. The Advisory Committee is appointed under the Protection of Birds Act, 1954, which came into force on December 1. The Act protects all wild birds, their nests and eggs, subject to specified exceptions; in particular, owners or occupiers of land may take action against specified harmful birds, and specified sporting birds may be shot outside the close season. The Act also restricts the sale and importation of birds and eggs and enables sanctuaries to be created.

Commonwealth Bursaries Scheme of the Royal Society and Nuffield Foundation: Awards

Awards under the Commonwealth Bursaries Scheme of the Royal Society and Nuffield Foundation have been made to the following: Dr. A. d'A. Bellairs, reader in anatomy, St. Mary's Hospital Medical School, London, to study material in South Africa during June–September 1955, in connexion with his work on the morphology and development of the vertebrate skull; Dr. D. A. Brown, senior lecturer in geology, Otago University, to study type-collections of the fossil Cyclostomatous and Cryptostomatous Polyzoa principally in London and Cambridge during 1955; Prof. S. N. De, professor of pathology, Nilratan Sircar Medical College, Calcutta, to study at University College Hospital Medical School, London, during June–September 1955, the mechanism of action of the cholera vibrio; Dr. A. J. Matty, lecturer in zoology, University of Nottingham, to visit Bermuda during March–September 1955 to extend his observations on the thyroid gland of bony fish; Dr. T. A. O'Donnell, lecturer in chemistry, University of Melbourne, to study inorganic fluorides at Cambridge during 1955; Dr. J. C. Smith, demonstrator and lecturer in chemistry, University of Oxford, to visit Pretoria and Melbourne during January–September 1955, to study methods of research on the chemistry of fats and waxes; Mr. W. Thomson, of the Rowett Research Institute, Aberdeenshire, to study sheep nutrition projects in Australia and New Zealand; and Prof. A. Wood, professor of geology, University College of Wales, Aberystwyth, to extend his researches, in Australia during January–May 1955, on the wall structure of the Foraminifera, to type and topotype material. This is the second group of awards under the scheme, which was instituted in 1953 to provide facilities for increasing the efficiency of scientists of proved ability by enabling them to pursue research, learn techniques or follow other forms of study in natural science in countries other than their own in the British Commonwealth.

Central Glass and Ceramic Research Institute, India: New Bulletin

The Central Glass and Ceramic Research Institute, which was opened in Calcutta in 1950, has now issued its first quarterly *Bulletin*, "devoted to the cause of the advancement of glass, ceramic and allied science and industries" (1, No. 1; August 1954; pp. 44; annual subscription Rs. 6 or 12*s*.; single issues Rs. 2 or 4*s*.). It is stated that each *Bulletin* will include a discussion of important current topics relating to the ceramic industry, and in India, as in the United States, the ceramic industry is taken to include the manufacture of glass and vitreous enamels in addition to pottery, clay building materials and refractories to which the term is confined in Britain and Western Europe generally. The *Bulletin* will also contain technical articles, manufacturers' experience, articles on production and quality control, new developments, answers to inquiries, trade statistics, news and reviews, books and abstracts. In this first issue there are two technical articles. The first deals with glass containers suitable for distilled water and is by Atma Ram (director of the Institute), S. P. Krishnaswamy, P. Roy and Sudhir Sen; original work is reported in a well-written manner, and definite recommendations are made for the benefit of the Indian glass manufacturer. The second technical article is on saggars

for use in the pottery industry, and is an abridgment of a paper previously published in the *Journal of Scientific and Industrial Research* [India]. The *Bulletin* is well produced, and provides a good illustration of the change in outlook that is taking place in India at the present time.

Insects and the Diseases of Conifers in New Zealand

In "New Zealand Forest Research Notes" (1, No. 8; October 1953. Wellington: Government Printer), the forest pathologist, G. B. Rawlings, discusses insects of *Pinus radiata* forests in New Zealand, giving a list of all the insects known to have any connexion with *Pinus radiata* forests in the country. *P. radiata* is an introduced exotic species of conifer and has been widely planted. Introduced exotics, whether forest or agricultural, planted as pure crops on a large scale in many parts of the world, have proved to be very subject to attack by fungus or insect pests, some of which are of local origin, and the others introduced. With the presence of extensive pure crops in the countryside, the danger becomes greatly aggravated, and heavy losses may be entailed by the dangerous attempts to provide within short periods rapid-growing crops to supply either an existing demand or to obtain high financial returns. There are countries where the introduction of exotics (New Zealand is an instance) to increase the area of forests in the country is fully justified. The Forest Department of New Zealand commenced planting conifer exotics early in the present century. Private companies took up the work, with the result that many large areas of exotic conifers, such as *P. radiata*, for example, exist in pure blocks. Coleoptera and Lepidoptera (for example, *Tortrix*) may prove exceptionally dangerous, attacks once started spreading with great rapidity and getting the upper hand. An annotated list has been compiled with the main objective of recording all insects known to have any connexion with *P. radiata* forests in New Zealand. As the author writes, it is important for the forest officer to understand at least the rudiments of the life-histories of the insects, because species thought to be unimportant may suddenly become significant under certain conditions. It is not only in Europe where the forest officer has had to face sudden outbreaks of this type; the more dangerous are new countries where forestry conditions are not so well understood, and unknown and untried exotics have been introduced.

Society for the Promotion of Nature Reserves: Handbook for 1954

The handbook for 1954 of the Society for the Promotion of Nature Reserves (pp. 64+8 plates; from the Society, c/o British Museum (Natural History), London, 1954; 5*s*.) includes the annual report and financial statement for the year ended March 31, 1954. The lease of Wood Walton Fen to the Nature Conservancy has greatly reduced the Society's outgoings, and its membership has increased. Further, it is no longer necessary to keep in being the many regional investigation committees set up some years ago, some of which have been converted into committees of local natural history societies or trusts. At the annual meeting of the Council on July 1, 1954, the president, Lord Hurcomb, emphasized the ability of the Society to stimulate public interest in, and support for, the Nature Conservancy and said that the Society also endeavours to extend such interest and support to the protection of flora and fauna and scenic beauty elsewhere, in close association with the International Union for the Protection of Nature and the British Co-ordinating Committee for Nature Conservation. The Society is also able and ready to give financial support for the preservation of areas which may not on scientific grounds justify in present circumstances the limited funds of the Nature Conservancy but need and merit protection before they are lost for ever. Specific examples of how this has been done in Lincolnshire are given in a lecture on the Lincolnshire Naturalists' Trust, delivered by Mr. A. E. Smith at the annual meeting of the Society on July 1 and which is published in the handbook. The handbook also includes an illustrated account, by Mr. E. J. Mason, of the island of Steep Holm, in the Bristol Channel, and the Steep Holm Trust; a note by Mr. F. H. W. Green on the progress of the Nature Conservancy in the acquisition and safeguarding of sites of special scientific interest; a note on the Nature Protection Conference at Beirut; and an illustrated account, by Dr. L. Machwa, of experiments which the Lower Austrian Nature Protection authorities have made with propaganda posters on Nature protection.

Exhibition of Historic Astronomical Books

The exhibition of historic astronomical books which is currently being held at the Science Museum, London (see *Nature*, August 14, p. 298), is one of a series designed to illustrate science and technology and their histories by means of the written word or pictorial representation, as distinct from the actual apparatus or products. In addition to those in the Science Museum's own possession, the Royal Astronomical Society has lent many valuable books. The catalogue of the exhibition (Museum Book Exhibition No. 3: Historic Astronomical Books. By G. H. Adams and H. R. Calvert. Pp. 29. London: H.M.S.O., 1954. 2*s*. net) contains the titles of seventy-five books, the first of which is Newton's "Philosophiæ Naturalis Principia Mathematica" (1687) and the last Struve's "Stellarum Duplicium et Multiplicium Mensuræ Micrometriciæ" (1837). No books published within the past hundred years have been included, for which reason modern works (such as those of Einstein, Eddington, Jeans and Lockyer) which rank as historic books are not mentioned. When books are published in a language other than English, a short title, sufficient for identification, is first given in the original language, followed by an English translation of some or all of the original title. An alphabetical index of authors appears at the end of the catalogue.

Announcements

Prof. P. A. M. Dirac, Lucasian professor of mathematics in the University of Cambridge, has been granted leave of absence for the current academic year by the University. Prof. Dirac is now visiting the Tata Institute of Fundamental Research at Bombay, where he is staying until early in 1955, after which he is proceeding via Japan and Vancouver to the United States for a short visit, and then to the National Research Council of Canada at Ottawa.

Erratum. In the article entitled "Differentiation of Growing and Non-growing Bacteria by a Staining Technique" in *Nature* of November 13, on p. 921, col. 2, line 35, the time of staining should read "30–60 sec.", not "30–60 min." as printed.

NEW NATURE RESERVES IN ENGLAND AND WALES

THREE new nature reserves in England and one in Wales were declared by the Nature Conservancy on November 24, and a further two acres were added to the Bridgwater Bay Nature Reserve, by the declaration of Steart Island, off the mouth of the River Parret, on the termination of an existing tenancy. Steart Island, which is separated from the mainland at high tide by half a mile of water, is the roosting-place for hundreds of geese, mainly white-fronted geese, and is the only known area in Britain where moulting shelduck gather each summer; for this reason it is hoped to keep the island entirely undisturbed.

Cwm Idwal Nature Reserve, the first Welsh nature reserve, and the first to be declared in a national park, is a natural amphitheatre rising to above 3,200 ft. in the heart of Snowdonia National Park, about four miles north of Snowdon, and this 984-acre area has been leased to the Conservancy by the National Trust, subject to existing farm tenancies. Its wide variety of volcanic rocks carries an interesting flora, dating from immediately after or even before the latest Ice Age. Green spleenwort, lloydia, purple saxifrage, water lobelia and quillwort are found there. The University College of North Wales, Bangor, will continue to use Cwm Idwal for botanical, research and teaching purposes, and the Conservancy's own work will probably include work on the inter-relation of vegetation and soils and the effect of grazing on some of the important plant communities. Climbers and mountaineers accustomed to visit the area will find no change in access; but formal applications must be made for research in the Reserve or for collecting specimens of animals or plants.

Blelham Bog Nature Reserve, lying on the north-western edge of Blelham Tarn, three and a half miles south-west of Ambleside, is a rare example of the development of sphagnum bog from wet wood-land, very little of which now remains. The vegetation is mainly *Sphagnum–Molinia–Myrica* bog with unusual species such as great sundew, white beak-sedge and downy sedge and many of the bog mosses characteristic of this type of transitional environment. Of the caddis flies found there, *Limnophilus xanthodes* McLachlan, extremely rare elsewhere in the Lake District, is fairly abundant. Access will not be restricted; but permits will be required for the collection of animals or plants in the Reserve.

The chief interest of Hartland Moor Nature Reserve, which covers 178 acres close to the Conservancy's Research Station at Furzebrook and is about one and a half miles south-east of Wareham, Dorset, is the domination of the vegetation in parts by the rare Dorset heath (*Erica ciliaris*). Other rare bog plants are also found in the Reserve, and there are interesting local variations in the flora, probably related to differences in the drainage. Public access will not at present be restricted; but permits will be required for collecting.

Arne Nature Reserve is a small section of Big Wood, about two and a half miles east of Wareham, and is one of the two known places in the country which show the natural transition from dry woodland to salt marsh—a brackish tidal condition. Parts of the wood probably represent the remains of the primitive broad-leaved forest; but it also contains such interesting features as the rare royal fern (*Osmunda regalis*) in a natural habitat. There are valuable potentialities for scientific research, notably into the effects of water-logging and the transition between salt marsh and either woodland or heath-land. Cord grass (*Spartina townsendii*) is present on the seaward fringe, where studies will be linked to the experiments on coastal vegetation at Bridgwater Bay. Permission to visit will be required, and also authority to undertake research or collect specimens.

INSTITUTE OF PERSONNEL MANAGEMENT

ANNUAL CONFERENCE

AT the forty-first annual conference of the Institute of Personnel Management, which was held at Harrogate during October 8–10, the opening speaker was Admiral Sir Denis Boyd, principal of Ashridge College. On the general theme of leadership, Sir Denis said that he is convinced that people cannot be trained in its most important aspects. In leadership there is a combination of technique and personality; the technique can and should be taught to everyone in any kind of authority, the crux of the technique being administration. Problems are not solved by inspired decisions, he continued, but by constant thought, intelligent anticipation, waiting, foresight, patience and organization—that is, administration. The delegation of responsibility is the key to wise administration. Among the attributes of leaders are enthusiasm, austerity, sincerity, courage and humility.

Sir Miles Thomas, chairman of the British Overseas Airways Corporation, discussed the changing pattern of British industrial management. First, he said, there was the development of specialized management—the breakdown of management into a variety of techniques. In the early days of British industry and up to the early years of the twentieth century, the 'boss' of the firm was the owner. He alone carried the risk of losses and reaped the reward of profit; it was his financial credit, and that of the bank, which determined how easily he could get fresh capital for expansion. The owner naturally had the undisputed right to 'hire and fire' when and how he liked and, within broad limits, to pay just as much or as little regard as he felt inclined to working conditions or to wages.

Gradually, the demands of technical development, commercial competition and, above all, of the pressing need to raise more capital to keep pace with the growing scale of operations and expansion, produced two changes almost simultaneously. First, the owner found that, to obtain the necessary capital, he was compelled to turn the concern into a joint stock company, with ownership in the hands of the

stockholders, while he himself was appointed managing director. Secondly, the scale of the managerial problem presented by the growth in size and complexity of the business meant that no longer could he, even as managing director, deal with every side of the business himself. From this situation there emerged the manager as a person and a position to be respected. He became the final authority from whom originated instructions on policy and on their execution. Inevitably there grew up specialists in the various branches of management. Production and sales were the first to be clearly separated, and these were followed by various dichotomies and drafting processes until, by the end of the First World War, the familiar pattern of production, sales, finance, research, planning and buying was becoming the general rule.

This division of labour at the highest level called at once for a better quality of general management than had hitherto been required. The second feature of the industrial and commercial management scene was the changing balance of emphasis and importance between the several elements of specialist management. The period immediately after the First World War was mainly one of developing the selling power of British goods. Consumers had to be found and shown that their interest was best served by buying a particular line of goods. Above all, the sales manager had to have sufficient authority to see to it that the technical or production departments produced the goods he wanted. In response to the developing authority of the sales department, powerful incentive was also provided for the development of research in industry, both of a fundamental nature and in the various technological processes. This era of the growing power of sales management was succeeded by the development of financial management. The growing complexity of the financial structure of the big joint stock company, the stringent requirements of the various Company Acts and the ever-pressing pressure of the Inland Revenue, produced a demand for experts in this field to be represented in the executive management of most concerns of any size.

The end of the Second World War saw the emergence into a new importance of the latest development of specialized management—personnel. Due to the immensely significant social and economic changes in the years immediately following the Second World War, there was at once an overwhelming and critical demand from men and women in industry to be regarded each as individuals with rights and responsibilities. This meant that the element of executive management which should be the last which any managing director wishes to delegate became rapidly of vast and specialized importance in the form of a personnel or employee relations department. This further specialization of management into personnel or staff management shows the emergence of the conception of the responsibility of industry to society.

There seem to be three main ways in which developing economic and social patterns have emphasized the importance of personnel management since the War. First, the significance of the individual has been underlined in a purely practical way. It has been generally appreciated that the application of large sums of money and intense research effort by the best technical brains available to securing and devising exactly the right piece of equipment to perform a certain job can be rendered largely nugatory if the men and women who operate it are so ill-suited to the task that they do not get the best out of it. Secondly, society's demand for equality and justice generally bears directly on the personnel manager's job. In this context there is also the vastly important field of relations with the trade unions. Thirdly, the personnel function has been heavily emphasized by the vast range of problems involved in getting more out of a group of people than the sum of their individual efforts.

Mr. C. J. Geddes, president of the Trades Union Congress, considered the role of trade unions in the future. During and after the Second World War, he said, there has been a profound change in the attitude of the trade union movement, and an attempt is being made to avoid a clash with employers and management. In the immediately foreseeable future, however, the fundamental purpose of the trade union movement will not change, nor will officials cease to strive in every possible way to get every farthing they can for their members. They will not abandon their right to use force. The driving spirit of the trade union movement does not rest with the leader, nor is the policy determined by the leader, but by the individual member.

There has been no fundamental change in the outlook, purpose or objective of the trade union movement, continued Mr. Geddes. The trade union leader is no longer a bitter enemy of the employer; but he is not yet his friend. There is not the slightest hope in the foreseeable future of the trade union movement agreeing to a national wages policy, not only because of the extreme difficulty of trying to devise one, but also because the trade union movement would largely sacrifice its purpose if it did so.

Will the trade unions demand a greater share in the management of industry? Mr. Geddes thinks they will, and it may be one of the major differences between the trade union movement and the employers in the immediate future. This does not mean that trade unions are going to demand that they must have joint control, but that they should become more and more equal with management and have much more information about the operation of particular industries.

Looking at the industrial scene, Mr. J. B. Priestley, the author, declared that there is a danger that our highly industrialized urban life may rob men of so many of the primary satisfactions that, in their sense of frustration and resentment, they may create a society so violent that it will explode in our faces. There are certain things men and women want: the English love to use their energy intermittently—they do not want to use the same amount every day, or to be harnessed to something keeping a regular tempo. He hoped that, as industry develops, it will be possible to make machines gear themselves to men and not men to machines. Everything—even employment and hours of work—is too regular: people do the same dullish job too long. We are in danger of creating a highly industrialized society which has lost all feeling for the soul or for any notion of man as a spiritual being—a society that might imitate the cruelties of ancient Rome to release its feelings of frustration.

The second danger in this industrial age, continued Mr. Priestley, is that the future organization of human affairs may deteriorate because we are not producing good human beings to take charge of

them. We spend thousands of pounds on education, but to what end? It is no good pouring money into a school unless we are going to spend money and take time and trouble over the street outside the school; environment will always defeat education. Looking at Britain as an environment, it is important to think of the forces playing on the people personnel managers have to handle: we should think of the way such people are not encouraged to think for themselves at all. The reason why young working people are not showing any sort of enterprise is the recent creation of a complete mass working-class culture.

To keep industry going, we need a fair proportion of young men and women who are individuals with initiative, who think for themselves and have some sense of mental and spiritual development. We should do everything to make that possible, because we do not want our great-grandchildren to be living in an ant-heap and to be indistinguishable from the robots they might be making to serve them.

A valuable feature of the Conference was a number of 'brains trusts' sessions at which experienced personnel officers answered questions on such varied themes as work and health; management training courses; wage differentials; and discipline and full employment.

T. H. Hawkins

NUTRITION AND THE ALIMENTARY TRACT IN MAN

THE Scottish Group of the Nutrition Society held a conference in Dundee on October 23 on "Disorders of the Alimentary Tract and their Nutritional Effects". In discussing disorders of fat absorption, Dr. J. M. French (Department of Pharmacology, University of Birmingham) said that fat absorption is defective in many clinical conditions, often as part of a generalized absorptive defect. Assessment of the degree of defect of fat absorption cannot be made by microscopic examination or percentage fat in the wet or dry fæces, and some type of fat balance must be employed. A continuous study of fat absorption, using the rapid daily fatty-acid estimation of Kamer, Huinink and Weijers, is essential if results of treatment or other procedures are to be assessed in a reasonable period of time. The accumulation of data with the same rapidity by the use of balances at intervals is precluded by the great day-to-day variability shown by subjects with defective fat absorption. The continuous method is especially applicable to such problems as the effective replacement therapy of pancreatic insufficiency with various types of pancreatic extract.

Wheat and rye gluten as a causative factor in cœliac disease, originally demonstrated in Holland by Dicke, Weijers and Kamer, has been amply confirmed in Britain. Although many adult cases of idiopathic steatorrhœa have a history of cœliac disease in childhood, the response of the adult to a wheat gluten-free diet is disappointing. Five cases of complete recovery have been recorded, however, suggesting that it is the basic factor. Failures may be due to superimposed vitamin deficiency, sensitivity to factors other than wheat and rye protein, or increased bacterial growth in the rich medium provided by the slow absorption of food. Evidence for the latter in tropical sprue has been provided by the use of intestinal chemotherapy.

Specific infection, dietary deficiency and tropical conditions are unsatisfactory as theories for the primary cause of tropical sprue. Considerable evidence has been accumulated to suggest that oxidative rancidity of unsaturated cooking oils may start tropical sprue, the intestine being irritated by some chemical constituent. This evidence is provided by the fact that sprue is rare in tropical countries such as Africa where saturated fats are consumed, but common in India and the Far East where cooking oils, such as rapeseed, sesame and mustard oil, are consumed. The high incidence in India among European and Indian troops during 1942–45 coincided with a change in dietary fat intake both in quantity and type, which would be in conformity with this theory. Experimental support is given by work in rats, which rapidly develop diarrhœa, steatorrhœa, emaciation, anæmia and death, if fed on rancid unsaturated fats.

Dr. R. H. Girdwood (Department of Medicine, University of Edinburgh) spoke on the occurrence of vitamin-deficiency conditions related to disorders of the alimentary tract. Conditions that interfere with vitamin intake include destruction of the area of the stomach that secretes the 'intrinsic factor'; rapid passage of vitamins particularly as a result of fistulæ; stagnant or blind loops of small intestine; and disease of the intestine or mesenteric glands.

Clinical impressions of specific vitamin deficiencies are misleading, and biochemical loading tests are not very satisfactory. Nevertheless, a differential urinary folic-acid excretion test is of diagnostic value in showing poor absorption of folic acid in conditions such as idiopathic steatorrhœa. After total or partial gastrectomy operations, or even after a gastro-enterostomy, megaloblastic anæmia may develop; steatorrhœa may also occur, but serum vitamin B_{12} tests show that the deficiency is of vitamin B_{12} and not folic acid. Where an anæmia is the result of a stagnant loop, it may not respond to any vitamin therapy, and presumably toxins are being absorbed from the loop.

The interpretation of studies of vitamin balance is complicated by the metabolism of the microbes found in the alimentary tract. Strains have been demonstrated both to synthesize and to absorb such vitamins as cyanocobalamine; their net influence is still uncertain, and may vary in different conditions.

Dr. D. A. K. Black (Department of Medicine, Royal Infirmary, Manchester) discussed the effects of alimentary disease in mineral metabolism. In general, chronic alimentary disease leads to mineral malnutrition as a result of deprivation and malabsorption of food minerals, while in acute catastrophes the loss of alimentary secretions is the predominant feature. Disease of the alimentary tract is the principal cause of potassium depletion, and has been demonstrated in pyloric stenosis, gastro-enteritis, ulcerative colitis and steatorrhœa and even as a consequence of excessive use of laxatives. This may result from deprivation of food intake, which is usually of the order of 100 m.equiv. daily, increased loss in the stools, and loss by vomiting. The potassium content of alimentary secretions is about one-tenth of the sodium content, so that in acute disturbances sodium depletion predominates; nevertheless, significant loss of potassium may occur, in chronic disease partly because colonic absorption of potassium is much less complete than that of sodium and partly because renal loss of potassium is greater than that of sodium when there are comparable body deficits of the two

ions. The catabolic response to surgery leads to further loss. When potassium has to be given by intravenous injection, it should not be of greater concentration than 40 m.equiv./l.

It is generally agreed that faecal excretion of iron represents unabsorbed iron. Impaired absorption has been observed in the steatorrhœa syndrome even in patients with neither achlorhydria nor overt diarrhœa. Moderate impairment can often be countered by oral administration of iron salts, but severe cases require intravenous injections.

The pathogenesis of osteomalacia in association with steatorrhœa is complicated. First, the presence of excessive fatty acid in the bowel leads to the formation of calcium soaps the calcium of which is not available for absorption; this can be improved by a low fat diet. Also, vitamin D is poorly absorbed, and further improvement of absorption can be induced by parenteral vitamin D or very large doses by mouth. The prolonged treatment of peptic ulceration with large amounts of milk and alkalis can lead to calcium intoxication and, in severe cases, renal failure associated with calcification of the renal tubules.

Prof. R. B. Hunter (Department of Pharmacology and Therapeutics, Queen's College, Dundee) reviewed the method of clinical presentation of fifteen cases of idiopathic steatorrhœa recently studied in the Therapeutics Unit, Maryfield Hospital, Dundee. In less than half these cases was diarrhœa the predominant symptom though all complained of tiredness and loss of appetite. The patients learned to control their own diarrhœa by reducing their fat intake. Cases of apparent iron-deficiency anæmia with malabsorption of fat, macrocytic anæmia or megaloblastic anæmias responding to folic acid were shown. Two cases of extreme calcium deficiency were considered in detail, and the problems of finding an effective means of calcium replacement in the face of impaired alimentary absorption were considered.

Food allergy was discussed by Dr. J. A. Milne (Department of Pathology, University of Glasgow), who said that, in order to discuss food allergy, it is necessary to consider first certain basic facts concerning allergic reactions and the immunological basis of allergy. When an antigen first enters the body, it stimulates the formation of specific antibodies. Some of these antibodies tend to persist in their free state in the circulating blood (circulating antibodies), and this would appear to constitute immunity. Others become incorporated into the substance of cells and become 'sessile' antibodies or fixed antibodies, and so the allergic state is established. Why some people develop sessile antibodies and thus become hypersensitive is completely unknown. Various sites may be affected—for example, the nasal mucosa and conjunctiva, the skin, etc.—and tissues so affected are known as 'shock organs'. What actually takes place when a tissue containing sessile antibodies comes in contact with its specific antigen is not known. There is considerable experimental and clinical evidence to suggest that histamine or a closely related substance is released.

Proof of the existence of food allergy depends on the demonstration of a cause-and-effect relationship between the ingestion of a given food and the production or accentuation of the patient's symptoms. The use of skin tests, either by the scratch or intradermal technique using concentrated extracts of foods, may occasionally be of help, although on the whole the results tend to be disappointing. Fortunately, many persons with food allergy, as well as having sessile antibodies, have some circulating antibodies. This allows the use of the Prausnitz–Kustner reaction for diagnostic purposes.

The ideal treatment of food allergy is, of course, the avoidance of the offending food, if this be known. The most widely used drugs at present are the antihistamines, and the results with them other than in papular urticaria in children are rather disappointing. Cortisone and adrenocorticotrophic hormone have been used with good results, although the symptoms tend to recur with increased severity once the drug is withdrawn.

FERROELECTRIC PROPERTIES OF SINGLE CRYSTALS

A COLLOQUIUM on the ferroelectric properties of single crystals, arranged by the Radio Components Research and Development Committee, was held at the Signals Research and Development Establishment, Christchurch, Hants, during September 16–17. Some sixty scientists attended in response to invitations, the Armed Services establishments, the universities and industry being represented in fairly equal numbers. The Bell Telephone Laboratories, New Jersey, which had supplied a number of large crystals for investigation by British workers, were represented by Dr. B. T. Matthias, who has achieved international reputation in this field. W. Bol and S. Duinker, representing Philips, Eindhoven, were also present.

The first paper, presented by C. F. Oxbrow (Christchurch), was prefaced with a short account of the fundamentals of the structure of barium titanate and their relation to electrical properties. Representative figures measured at Christchurch for the Bell crystals were saturation polarization, 22·5 μcoulombs/cm.^{2}; hysteresis loop area, $1{\cdot}4 \times 10^{-3}$ joules/cm.^{2}; permittivity along c-axis, 300 at room temperature. The optical properties of the Bell crystals were then described. These crystals, plates $1 \times 1 \times 0{\cdot}02$ cm., had a large area with the optic axis normal to the plate but were crossed by occasional laminar wedges of twinned material inclined at 45° to the plate. Seen by polarized light, these wedges produced broad interference bands on a uniform background. These twin domains were removed by the application of an electric field. A colour film of this type of domain change was shown, and inferences drawn on domain magnitude and growth. The paper concluded with a description of measurements to determine the refractive index n_0 accurately, the methods described being particularly applicable to these crystals. A modification of Chaulnes's method led to a value $n_0 = 2{\cdot}49$.

P. Parsons (General Post Office Research Laboratories) exhibited photographs of the Bell crystals showing the crinkling due to the laminar domains as seen by ordinary light, the changes brought about by heating to the Curie point, and the re-establishment of the original domains by an electric field. Electrical measurements were also described. The charge/voltage hysteresis loop was particularly square; the coercive field was of the order of 1·1 kV./cm. at 50 c./s. but only 500 V./cm. for direct current; in the region of the Curie temperature an electric field gave well-defined double or constricted loops. The behaviour of domain walls is evidently

dependent upon the rate of change of field because measurements showed a sharp peak in the differential permittivity at a bias field equal to the coercive field. The frequency of the small measuring field was 100 kc./s. and that of the large bias field 50 c./s. These results contrast with the substantially field-independent value measured at Christchurch using d.c. bias.

D. Gibbs (University of Bristol) discussed domain changes. 90° walls which separate regions with polar axes at 90° are easily observed. 180° walls separate antiparallel regions and are observable by polarized light only when additional cross-stress is applied. 180° wall change, equivalent to domain reversal, takes place by nucleation and growth of spike-like domains in the direction of an applied field[1]. Both 90° and 180° wall changes are possible in single crystals. In ceramics the electrical stress set up normally precludes 180° wall changes, and a parabolic (x, D) relation $x = kD^2$ due to 90° wall movements is obtained. Measurements at Bristol of electric displacement D and thickness-strain x produced values of k up to 5×10^{-8} e.s.u. In very pure barium titanate ceramic a flattening of the (x, D) curve at the vertex could be explained by 180° wall changes occurring at low field. In this pure ceramic a kink appeared in the side of the familiar D/E hysteresis loop if the applied a.c. field was suddenly increased. The kink grew out at a rate dependent on temperature, and this could be evidence of the nucleation period involved in 180° wall changes.

Problems which have arisen in growing single crystals of barium titanate were discussed by J. Herbert (Plessey, Ltd.). A pure intimately mixed raw material was made by incinerating barium titanium oxalate. The Verneuil oxy-hydrogen blow-torch method was tried. Lack of success in growing large tetragonal crystals was due to the growth of crystals in the hexagonal habit. To obtain barium titanate in the tetragonal form by crystallization from a melt of titanium dioxide and barium oxide, it was necessary to use a flux. Barium chloride yielded nearly perfect crystals of barium titanate in the form of thin plates, but the yield was small. Potassium fluoride yielded crystals in the form of 'butterflies', pairs of triangular plates joined along one edge. A lively discussion followed between Dr. Matthias (Bell Laboratories), Mr. Rhodes (Standard Telecommunications Laboratories) and Mr. Herbert on the merits of the potassium fluoride method as used by J. P. Remeika[2] in growing the excellent crystals described by the earlier speakers. Dr. Matthias also said that Mr. Remeika had succeeded in converting by heat treatment the hexagonal into the cubic form and vice versa. Evidently the fluoride method should be used for obtaining flat plates, while other methods such as the Verneuil might provide shapes suitable for piezoelectric investigations.

D. Campbell (Plessey, Ltd.) described major differences between crystals grown from barium chloride and potassium fluoride solvents. The potassium fluoride crystals had a surface strain layer which gave a square-net pattern under polarized light; the pattern disappeared and then returned when the crystals were heated and cooled through the Curie temperature (120° C.). The strain layer was etched away by phosphoric acid. Above the Curie temperature the optical activity of the chloride melt crystals completely disappeared, whereas some activity persisted in the case of those from fluoride melt. X-ray photographs indicated the normal contraction of c/a ratio with temperature in agreement with observed birefringent changes for the 'chloride' crystals. The 'fluoride' crystals had very complex photographs at 85° C. Hysteresis loops were directly dependent on complexity of structure. The American fluoride-melt crystals had ferroelectric constants agreeing with those of the chloride-melt crystals although the hysteresis loops were much more square.

In summarizing his work on sodium niobate, Dr. L. E. Cross (University of Leeds) reviewed previous work and anomalies between optical, electrical and X-ray measurements examined. His method of preparation and selection of single crystals for examination was described. Details were given of measurements of birefringence, type and arrangement of internal twins and dielectric constants over the temperature range −195° C. to +650° C. Owing to excessive conduction, observations of the effect of high electric field were given for the range −190° C. to +20° C. only. Summarizing, above 340° C. sodium niobate was not tetragonal but had orthorhombic symmetry, and there were two further changes before it became cubic at 638° C. The anti-ferroelectric structure at room temperature was confirmed, and there was some evidence of an additional ferroelectric polarization at low temperatures.

Two further papers on theoretical aspects of ferroelectricity were contributed by Drs. H. F. Kay and A. Devonshire (both of the University of Bristol). Dr. Kay dealt with the crystal structure of perovskite materials, with emphasis on $(Cd,Ca,Sr,Ba)TiO_3$, $(Li,K,Na)NbO_3$ and $(Li,K,Na)TaO_3$. Present knowledge is still only sufficient to indicate which materials are likely to be electrically unstable and the probable effects of substitutional replacements. The concept of ionic packing determines the probable type and magnitude of distortion at room temperature in the TiO_6 octahedra characteristic of the perovskite structure. These factors can be correlated to the probable type and frequency of twinning. In barium titanate the barium ion is so large that the structure can be broken down into sheet-like Ti-O groups, accounting for the polar character. The process is essentially ionic, since recent electrical measurements of saturation polarization agree with the value obtained from X-ray data on ionic shifts. The change in character of the distortion was traced as ion size was reduced progressively from barium through strontium until finally a tetrahedron-like formation was met in non-ferroelectric cadmium titanate. The substitution of lead produced anomalies which can be partially understood. Similar arguments are in general applicable to the alkali niobates and tantalates. In sodium niobate the structure is complex, and the unit cell quadrupled. Nevertheless, its field-dependent ferroelectric behaviour can be explained.

Discussing atomic models, Dr. Devonshire said that, while physical measurements are usually conducted at constant pressure, the constants immediately derived from atomic models are those for constant volume. For the perovskites the distinction is drastic. Thus in barium titanate the ferroelectric transition at constant pressure is discontinuous, a first-order transition, while calculations indicate that at constant volume the change would probably be second order. In contrast to ferromagnetics, the dipole interaction in ferroelectrics is long-range. Various types of model were considered by Dr. Devonshire: the type appropriate to potassium dihydrogen phosphate, in which an ion can take up two or more equilibrium positions; and that appro-

priate to barium titanate where the field in which the ion moves is anharmonic. The former gives with temperature a rapid change of χ, the reciprocal susceptibility or dielectric stiffness, while the latter gives a small change. Thus, the respective values of $\partial\chi/\partial T$ are 28·0 and 0·75. The Mason model for Rochelle salt was also considered. Here two sets of ions moving in unsymmetrical fields provide, as required for this material, a polar state stable only between two temperatures. A model for anti-ferroelectricity might be built on similar lines.

Both sessions were terminated by general discussions, Dr. Matthias presiding on the first day and C. G. Garton (Electrical Research Association) on the second. The subjects at both discussions were the practical uses of barium titanate crystals, with particular emphasis on digital storage. The fundamentals of storage and methods of investigation were described. Dr. Matthias said that the Bell Laboratories are concentrating on investigations into the serious deterioration in polarization properties caused by the protracted application of unbalanced pulse trains. Mr. Oxbrow said the deterioration is amplitude-dependent and is serious only if pulse amplitudes of the order of the coercive field are used. I. Carter (Ferranti, Ltd.) reported that, after the decay, a low-frequency property, sufficient storage effect exists for high-speed operation. Also, the initial state can be restored by periodic application of a small d.c. bias. Dr. A. Robinson (Ferranti, Ltd.) compared the merits of dielectric and ferrite storage. The advantages of barium titanate storage are compactness and a more convenient impedance for use in valve circuitry. Ferrite storage has the advantages of a more advanced state of development and, although offset by clumsiness, the versatility of variable 'turns-ratio' coupling. Very recent experiments with barium titanate indicate polarization times as low as 0·5 μsec., so that it might permit greater speeds of operation than ferrite.

A. C. Lynch (General Post Office) said that confirmation by Merz[1] that 180° walls do not move laterally has removed the fear that the polarizations of adjacent crystal areas might interfere. B. de Ferranti (General Electric Co., Ltd.) suggested that the non-linear characteristic of barium titanate capacitance versus field should be used in a dielectric amplifier. This would necessitate further investigation of noise in ceramics and single crystals. I. Ross (Services Electronics Research Laboratory) mentioned a possible use in infra-red switching, provided that the change in the 45° laminar domains is adequately fast. Measurements have been made of the infra-red transmission of one of the Bell crystals.

C. F. OXBROW

[1] Merz, W. J., *Phys. Rev.*, **95**, 690 (1954).
[2] Remeika, J. P., *J. Amer. Chem. Soc.*, **76**, 940 (1954).

SHIFT WORK IN INDUSTRY

THE Institute of Personnel Management (2–10 Hill Street, London, W.1) has issued a broadsheet surveying the issues which affect the application of shift systems in industry. The broadsheet has been prepared by F. P. Cook, of Courtaulds, Ltd., but is based upon information obtained from a large number of different industries.

Among the conclusions brought out in the survey is that the economic advantages of shift work are greatest where capital charges and overheads are high in relation to labour costs. The greater the proportion of the total cost of production that is occupied by labour costs, the less the economic advantages of shift work become. When shift work is first introduced in a discontinuous process where employment has previously been on day work, the double-day shift system is probably the most advantageous for all concerned—for management because it is a second shift which offers the greatest alleviation to fixed charges, and for employees because the physical and social disadvantages are much less than those of shift systems which involve night work. The appeal of shift work to employees depends largely on how attractive it is made financially. Although it is only one factor, shift work can prove a sound economic way of meeting the natural urge towards shorter hours of work and higher earnings.

Quite apart from the ballot which is usually required by law before women and young persons can be employed on double day-shift work, the investigations show that full explanation and consultation are needed before any successful shift system can be introduced. Of all shift systems, those involving night work are most likely to have a deleterious effect on health; this is especially applicable to systems which involve permanent night work. Any unfortunate effects will vary with individuals, the nature and hours of their work, and their habits outside the factory, so that it would be hard to establish a general rule, even if more evidence were available. For most employees, shift work involves a balancing of material gain against social loss; thus, in pursuing the possible economic advantages of the extension of shift work, which can only be a gradual process, those in authority must take the possible social drawbacks into account.

Mr. Cook concludes that one of the temptations of these complicated times is to over-simplify, and this is typified by the search for the single solution to any problem. In personnel management, recent years have seen the fashionable development of joint consultation, job evaluation, communications, financial incentives, financial enlightenment, merit rating of management development, and work study. Despite the creation of much pseudo-technical supporting jargon, not one of these is a cure-all by itself, and together they can be no more than further aids to the vastly complicated business of modern industrial management. The extension of shift work will not alone revive the fortunes of a nation or concern; but, in the right circumstances, it can help.

FORESTRY COMMISSION

REPORT FOR THE YEAR 1952–53

IN the operations of the Forestry Commission during the year 1952–53*, economy in spending was a guiding factor in deciding the programme of work. In order to carry out the expanding programme of planting and thinnings in the young plantations with the funds available, it was necessary to postpone work such as building new houses and new roads. Many of the forest services of the British

* Forestry Commission. Thirty-fourth Annual Report of the Forestry Commissioners for the Year ended September 30th, 1953. Pp. 84. (London: H.M.S.O, 1954.) 3s. net.

Commonwealth have found themselves in this predicament, which is by no means a new one. The rate of acquisition of land is still giving the Commission concern. The net additions of the past two years including acquired plantations have been substantially less than the areas planted. In 1951–52 they were less by eight thousand acres; this year by fourteen thousand acres. The total area of land acquired at September 30, 1953, was 1,909,400 acres. This comprised 1,181,400 acres classed as "Forest Land", which is either already planted or will be in due course, and 728,000 of "Other Land", which includes nurseries, rough grazing and agricultural land and other land unsuitable for planting. Twenty-six new forests were started during the year, nineteen in England, two in Scotland and five in Wales. The area planted was 67,610 acres, exceeding 1951–52 by almost six thousand acres. More than 118 million trees were used for the plantations and for replacing failures in recently planted ones. Fire damage was not high during the year.

The dedication scheme pursues its somewhat chequered course, dedication deeds being completed on 227 estates covering a total of 76,810 acres of woodland while another 139,730 acres of woodlands are in an advanced state of preparation; the total area thus approached a quarter of a million acres at the end of the year under review. It might be suggested as a matter for consideration, and to allay the difficulties of acquiring land, whether the Commission could not be advised to lay down a fixed minimum of land considered essential to be managed as State Forest and trust the private proprietor, with the Commission's advice and help where necessary, to work up to the balance of forest considered to be necessary for the requirements and protection of the population. France furnishes a good example. A considerable percentage of the French forests are privately owned and well managed. A question was once put to a senior French conservator of forests on the management of certain privately owned forests and whether the conservator ever gave advice, as they had a common boundary with the Government forests. He replied the private owner knew as much about forest management as he did. It may be concluded that British forest proprietors may in time attain as a body the same equality of knowledge as their French opposite numbers.

E. P. Stebbing

MANUFACTURE OF THE TEN-TOLA PRIMARY STANDARD WEIGHT FOR PAKISTAN

By Dr. G. F. HODSMAN

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THE first primary standard of mass to be produced commercially in Britain for many years, the ten-tola primary standard for the Karachi Mint, Pakistan, has recently been completed by L. Oertling, Ltd., in conjunction with Johnson, Matthey and Co., Ltd. (see *Nature*, August 14, p. 206). The standard of mass has been prepared to an exacting specification for the Pakistan Government, and its manufacture involved a number of special problems which are of general interest, especially to those concerned with precision weighing.

In order that a self-consistent system of weights can be established throughout the world, weights must be related through individual manufacturers' standards to some recognized ultimate standard of mass. It is not yet possible to rely on any natural phenomenon for such a standard, as is possible, for example, with length, which can be related to wavelengths of light. Recourse must of necessity be made to the mass of an actual piece of material, which in the case of metric weights is the International Kilogramme, located at the Bureau International des Poids et Mesures at Sèvres, near Paris. Most countries, including Britain, have primary standards of mass, which form the basis of their own weight system, the primary standard in Britain being the Imperial Pound. The weight system in Pakistan is based on the tola, which is defined as 180 grains (7,000 grains equals one imperial pound); the recently completed primary standard of 10 tolas thus has a mass of 1,800 grains (about 120 gm.).

A satisfactory primary standard must fulfil a number of requirements, the most important of which is stability, and its construction must be such as to ensure constancy and reliability of mass over a period of many years. The Imperial Pound, for example, is believed to have remained constant within one part in five million during the past seventy years. It is the achieving of this stability which presents the manufacturer with some of his most difficult problems.

The primary standard should be as near its nominal mass as is reasonably possible in order to avoid the difficulties surrounding the use of small 'make-weights' when comparing the standard with sub-standards. The standard should also be of reasonable size in relation to the sub-multiples and multiples in common use. For this reason, the 10 tola has been chosen as the primary standard as being a better intermediate value than 1 tola, which would involve difficulties in standardizing large multiples.

The Pakistan standard is made from an alloy containing 90 per cent platinum and 10 per cent iridium—an alloy which experience has shown to be exceptionally stable and durable. Since both these metals have a high density, the weight occupies a small volume and consequently has a small surface area, which also enhances stability. The density of the weight must not be less than 21·50 gm./ml. at 20° C. to ensure that it is sufficiently free from cavities and inclusions, which might affect its stability.

The alloy billet was forged by the firm of Johnson, Matthey and Co., Ltd., in Hatton Garden, London, and was subjected to gamma-ray examination to reveal any major internal defect. It was then roughly turned and polished and subjected to a density determination by the National Physical Laboratory at Teddington. The billet used for the weight was free from all inclusions and achieved a density of 21·54 gm./ml., which indicates a high degree of freedom from inclusions.

The shape of the final weight is a simple cylinder with a height and diameter of approximately one inch, the under-surface being relieved over its central portion, to provide an annular seating for the weight and to minimize the risk of foreign matter adhering to the under-surface when the weight is in use.

The mass of the weight was required to be adjusted within ± 0·005 grain (that is, ± 0·3 mgm.), which is about three parts per million of nominal value; the actual mass of the weight was required to be known within ± 0·0002 grain. In addition, a high degree of surface finish is necessary, for any imperfections in the surface are centres of potential corrosion and dust location. The problem facing the manufacturer, therefore, is gradually to improve the surface finish, removing smaller and smaller amounts of material as the nominal value is approached so that correct mass and optimum polish are achieved simultaneously. If the correct mass is achieved before optimum polish, the surface defects cannot be removed and the weight becomes scrap metal. If optimum polish is achieved before correct mass, it is difficult and sometimes impossible to reduce to correct mass without damaging the surface. The simultaneous achievement of these twin conditions is a process requiring exceptional skill by the polisher, together with a series of accurate weighings. It is a process which occupies many months of painstaking and patient work using successively finer and finer polishes. The manipulation of the weight during the long period of adjustment, with the ever-present necessity of avoiding damage throughout every second of this time, imposes a considerable strain on the adjuster.

Primary standards are standards of mass and, therefore, when compared in air with standards of different density, allowance must be made for the different buoyancy effects on the two sides of the balance. For the adjustment of the Pakistan standard, a secondary standard made from an alloy of 80 per cent nickel and 20 per cent chromium was used as a counterpoise. This counterpoise was prepared, finished and adjusted in the same way as the standard and was calibrated for mass and density by the National Physical Laboratory. The Pakistan standard was then compared with this nickel–chromium standard on a reference balance built by L. Oertling specially for the work. The balance was capable of indicating weight differences of 0·01 mgm. with a load of 120 gm. in each pan. At the final adjustment stages, Gaussian weighings were used, the platinum standard being allowed forty-eight hours to become stabilized after each adjustment and before re-weighing.

The final certification of the weight by the National Physical Laboratory records a value of 1800·0007 grains for the mass, the deviation from nominal value being only 0·0007 grain. This deviation is about one part in three million and is comfortably within the permitted tolerance.

THE *O* CHROMOSOMES AND THE DISTRIBUTION OF THE DENTAL FRICATIVES IN EUROPE

By R. W. THOMPSON

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IN their well-known introduction[1] to genetics, Darlington and Mather bring up once more the question of the relationship between race and language. Their thesis is that the 64·5 per cent line for the *O* chromosomes (in the *A—B—O* series) coincides with the boundary which separates those Europeans who pronounce a *TH* sound (as in English *think* and *then*; *AIP* notation [θ] and [δ]) from those who do not. Their story is ingenious, as are their sketch-maps. Unfortunately, they have simplified the issue and arrived at conclusions which we are not yet in a position to accept in the light of present knowledge. They themselves would appear to regard their paragraphs on this subject as mainly speculative.

Let us agree with Darlington and Mather's definition of *TH* as a 'dental fricative', unvoiced [θ] as in English *think* and voiced [δ] as in English *then*. Sounds with approximately the same values as these exist in other European languages but are often developments from a completely different phonetic base. For example, the [θ] of Spanish in *cielo* is derived from a primitive *k*-sound, whereas that of English *thin* descends from a postulated primitive *t*. While [θ], [δ] do not occur in many of the European languages, there is no reason for believing that normal Europeans have any *congenital* difficulty in pronouncing them. Children rapidly learn to discard myriads of sounds which do not conform to the type found in the language used by their parents.

At this point we shall look at the map of Europe and see what the position is in several of the areas where Darlington and Mather have registered the presence of the dental fricatives.

In the west, in Ireland it is claimed that the dental fricatives are extant. For some reason, West Kerry is marked 'extant variable'. The facts are that this group of sounds is absent from popular speech over most of Ireland, and only parts of the north-east could be labelled 'extant variable'. Orthography often confuses the layman. It should therefore be remembered that forms such as stage-Irish 'butther', 'Pathrick', 'murdher' represent a special group of sounds for which there is no provision in standard English spelling. They are 'velarized dental plosives' (voiced or unvoiced) and are produced by pressing the tip and blade of the tongue against the upper incisors. In the formation of these sounds the breath is cut off as in the production of English [*t*] and [*d*]. In the pronunciation of [θ], [δ] the flow of breath is continuous. The velarized dental plosives in the English of Ireland are examples of Gaelic 'substratum'. Children of Irish parentage, born in London, seem to have no difficulty in pronouncing [θ], [δ] in the English manner. One feels that the children of those who 'could not frame to pronounce' the word 'shibboleth' (Judges, xii, 4–6), if taken early enough, could have been taught to palatalize initial *s* in spite of the arrangement of their chromosomes.

Turning again to Spain, where orthographic *c* (before *e* and *i*) and *z* = [θ] in the standard language, we see that the phenomenon has not yet covered the whole country. Throughout Catalonia and Valencia in the east, the mother-tongue of the people shows *c*, *z* = [*s*], [*z*], respectively. Yet when Catalans or Valencians are obliged to speak the national language in the school or upon official occasions they are quite capable of pronouncing the *c* and the *z* in the Castilian fashion. In the south of Spain both these letters are pronounced somewhat like an English [*s*] in many districts, although written *s* is sometimes rendered as [θ]. Which means that *sí señor* may sound like *thee thenyor*. Now so far as the relationship between the use of [θ] and blood group genes is concerned, in Spain we must realize that (according to the recent researches of the late Amado Alonso[2]) the final passage of earlier *ts* and *dz* (written *c*, *ç*, *z*) > θ was not complete in either the dialect of Castile or

in the national language until the late sixteenth century. By about this same time these sounds had passed to [*s*] in America, southern Spain, and in the Judæo-Spanish of the descendants of the Jews expelled by Ferdinand and Isabella in 1492 and living in North Africa, the Balkans and elsewhere. Are we not justified in regarding the apparent coincidence of linguistic and genetic phenomena as irrelevant?

Portugal apparently lies beyond the 64·5 line and according to Darlington and Mather the only traces of *TH* are to be found in two areas. In one they claim that it disappeared before 1000 B.C. and in the other it is said to be 'extant variable'. Yet the facts speak differently. In peninsular Portuguese intervocalic *d* is often pronounced [δ] as in the other Hispanic languages and dialects.

In the Greek of Demosthenes[3] the group χ, θ, φ was pronounced [*kh*], [*th*], [*ph*]. In modern Greek (and, indeed, from early in the present era) they have the following values: χ = something like the two chief *ch* sounds of modern German; θ = [θ]; φ = [*f*]. One asks if before the passage of *t* + *h* > [θ] the *AB*/*O* blood group genes fought a bloody underground battle in the bodies of the Ancient Greeks.

The fundamental question is whether or not any race is incapable of or averse to pronouncing any given sound. From my own experience in various countries, such a theory cannot be proved. Here in Jamaica, when I listen in on the radio I cannot tell if the speaker is black, white or of mixed race. In Jamaica the educated black or brown man will say 'think', 'the', 'then' as easily as an Englishman. The poor-white farmer says 'dis', 'dat', 'dese', 'dose', 'ting', 'tink' just like his dark neighbours. The black man says 'tink' because his father did and not because of a certain arrangement of genes. The first of his ancestors to speak a kind of English, lacking [θ], [δ] in his own West African dialect, substituted a *t*- or a *d*-sound, the nearest equivalents he could find. In the same way, a Frenchman or a German may produce 'seenk' for 'think' and 'zees', 'zat', 'zeese', 'zose' for 'this', 'that', 'these', 'those', but not because he has anything wrong with his chromosomes. Indeed, if he were to allow his children to be brought up in Britain he would find that it was no more difficult for them to pronounce in the English way than for an English child, reared in France or Scotland, to say "*de bon vin blanc*" or "*At's a braw, bricht, munelicht nicht, the nicht*".

We admit that the speech organs of various races vary in shape, as does the texture of the hair, the colour of the skin or the form of the lips or nose. The only influences these variations could have on the production of speech is on 'timbre', and even this, as may be inferred from my remarks above, is not significant over the radio.

Finally, it does not seem that any valid conclusions can be drawn from the apparent coincidence of isogenic lines for blood-group frequencies and isophones for the distribution of *TH* = [θ], [δ] in Europe, in the light of our present knowledge of race and historical phonetics in that continent. Most linguists will continue to feel that human environment is a more powerful influence on language than heredity.

[1] Darlington, C. D., and Mather, K., "The Elements of Genetics", 359 (1949).

[2] Alonso, A., "Estudios Lingüísticos" (*Temas hispanoamericanos*) (Madrid, 1953).

[3] Meillet, A., and Cohen, M., "Les Langues du Monde", New ed., p. 43, *note* (Paris, 1952).

MEASUREMENT OF RHODOPSIN IN THE LIVING HUMAN EYE

By Dr. W. A. H. RUSHTON, F.R.S., and Dr. F. W. CAMPBELL

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THE photopigment rhodopsin has long been known to be the chemical basis of scotopic (twilight) vision, and its bleaching and resynthesis have generally been held to underlie the phenomenon of light- and dark-adaptation. It has never been possible, however, actually to measure the rhodopsin-level in the living human eye, except for the incidental observations of Brindley and Willmer[1], who, however, were unable to avoid rapid bleaching of the pigment by the light used to measure it.

In order to work at substantially lower luminance-levels, a photocell technique has been developed. Successful applications[2-5] of the method to the cat and albino rabbit (where the back-reflexion of light from the eye is strong) encouraged us to proceed to the far more difficult case of the human eye, and we now appear to be able to measure changes in the rhodopsin-level with an accuracy of about 5 per cent of the full dark-adapted amount, each measurement taking 5–10 sec. to make.

Light from a bright source passes through a rotating colour-wheel so that the light transmitted is alternately orange and blue-green (Fig. 1). This passes through a hole in the silvering of a cover-slip and is focused upon the cornea in a 2° pencil. Light reflected from behind the small illuminated patch of retina passes back through the dilated pupil and, after reflexion in the mirror, is focused upon the cathode of a photomultiplier cell (type 931 *A*), the output of which gives the signals alternately for orange and blue-green light. These two signals are separated by passing through a commutator mounted upon the shaft of the colour wheel. Condensers connected to the grids of two cathode followers act as reservoirs for the levels of the two signals, and a galvanometer across the cathodes gives a null indication when the levels are equal.

Nearly all the light entering the photocell has passed twice through the rhodopsin of the retina. This will scarcely affect the orange signal since rhodopsin is nearly transparent to orange light, but it absorbs maximally in the blue-green, so a change in the rhodopsin density will upset the null balance of the galvanometer. This may be restored by a corresponding change in the position of a purple wedge in the path of the incident light. The amount of purple wedge added is proportional to the amount of visual purple lost, which may thus be read directly. The technique is seen to have the usual advantages of a null method; it is relatively unaffected by changes of light source, of signal amplification and of small eye movements, though all these have been kept as steady as practicable.

If a fairly bright light is shone into the eye, rhodopsin is bleached, at first quickly and later more slowly as less and less pigment remains to absorb the light. Fig. 2 shows this curve measured in terms of the setting of the wedge. There are four different experiments: ○ and × show the bleaching of a 2° area of the retina 20° temporal to the fovea (the two experiments were similar but were performed three days apart to show the degree of repeatability);

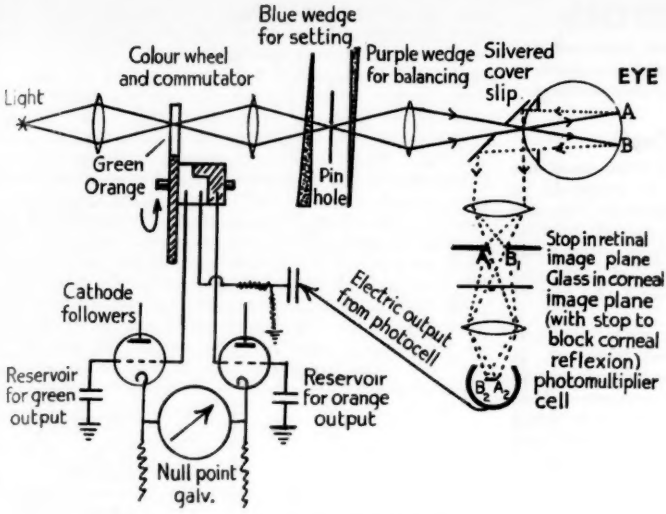

Fig. 1. Rotary rhodopsinometer

experiments ● and – were similar, but the areas measured were the fovea and the blind spot, respectively. The actual level of the plotted results is arbitrary; what is significant is that there is no bleaching in the fovea and blind spot. They are the only areas in the retina devoid of rhodopsin and they are the only places where we have found no bleaching. This leads us to believe that it is the bleaching of rhodopsin that we are measuring; the spectral sensitivity also corresponds to what would be expected from the bleaching of rhodopsin[6].

The sensitivity has been measured by finding the bleaching-rates in lights of different colours. As is well known, the scotopic visibility of any colour corresponds very closely to its power of bleaching rhodopsin. So the subject (W. A. H. R.) first matched the various coloured lights under scotopic conditions, and then his retina was bleached by exact multiples of these matched intensities (some 10^5 times as strong). Each colour gave the same rate of bleaching within 20 per cent as measured by the displacement of the purple wedge, though of course the orange light appeared enormously brighter than the blue due to the activation of the cones.

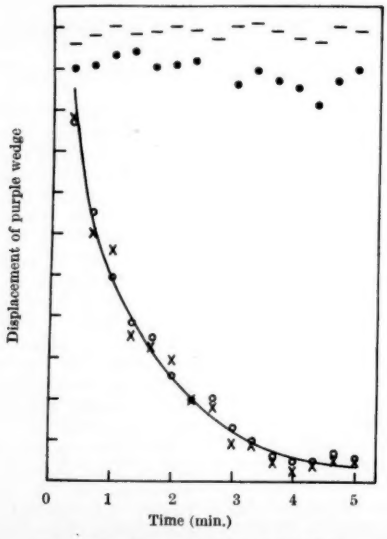

Fig. 2. Bleaching produced by bright light. ○, measurements on June 21, 1954 (20° temporal); ×, repeat measurements on June 24, 1954; ●, measurements in fovea; —, measurements in optic nerve head

Rhodopsin-Level and Visual Function

It has been widely held that a principal cause of light adaptation is the bleaching away of rhodopsin so that only a small fraction of the pigment remains to absorb the necessary quanta. Among many who have opposed this, Granit *et al.*[7] have not found the expected correlation in animals' eyes. Baumgardt[8] has calculated that insufficient quanta are absorbed to produce significant bleaching at the low luminances where the bleaching hypothesis was often used, and Rushton and Cohen[9] showed experimentally that some fifty-fold change of threshold was produced by less than 2 per cent bleaching of rhodopsin. This latter experiment has recently been repeated and confirmed by Wald and Hubbard[10].

All this work gives an upper limit to the amount of bleaching possible by assuming that no regeneration occurs, for there has been no reliable way of estimating the rate of regeneration. The present technique allows us to measure the rhodopsin-level directly and rapidly in various conditions of illumination. Work upon the kinetics has only just begun; but the following results are at once apparent. (*a*) The rhodopsin-level is in fact not appreciably altered by brief light adaptations such as those used by Rushton and Cohen[9]. (*b*) After strong bleaching, the subsequent return of the rhodopsin-level to its full concentration follows an exponential curve with half-return constant of about 7 min. (*c*) At moderate room illuminations there is not more than 10 per cent of the rhodopsin bleached when equilibrium is reached.

This seems to establish that unless fairly bright photopic illumination is used, there is no appreciable change in the density of retinal rhodopsin. Thus changes in visual sensitivity cannot be due to an alteration in the chance of a quantum being absorbed; it must be entirely due to a change in the efficacy of the quantum when it is absorbed.

We are indebted to the W. H. Ross Foundation and the Medical Research Council for defraying the cost of the apparatus.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Infra-Red Spectra of Coals

In the past, the infra-red spectra of solid materials which cannot readily be dissolved or prepared in very thin sheets have been determined by the use of suspensions of the substances in liquid paraffin ('Nujol'). We have reported spectra of some coals obtained in this manner[1], and observed that prolonged grinding is necessary in order to reduce the loss of radiation by scattering.

We have recently experimented with the new technique described by Schiedt[2] and Stimson[3], in which the substance to be examined is compressed with potassium bromide to give a translucent disk, and we have found that careful preliminary grinding of the coal and effective mixing of the coal and potassium bromide are of considerable importance. The influence of grinding time has been determined by preparing disks after milling 0·3 gm. coal for measured intervals of time in a high-speed miniature ball-mill. Fig. 1 shows the spectra of an anthracite milled for 5, 13 and 20 hr. It will be noted that after 5 hr. milling, the general level of absorption is high; after 13 hr., radiation scattering by the coal particles is high from 3,500 to about 1,500 cm.$^{-1}$ but the general level of absorption is lower. After 20 hr., the general level of absorption shows little further change, and radiation scattering, even at the high-frequency end of the spectrum, appears insignificant. Bergmann has recently reported[4] coal spectra obtained by this method; but there is evidence that scattering is still appreciable in the region 3,500–2,400 cm.$^{-1}$ although the general level of absorption is low. This is probably due to insufficient grinding of the coal sample.

In examining a series of coals, we have consequently adopted the policy of milling each for such time that further milling produced no change in the spectrum; in the case of the anthracite, the time involved was 20 hr., whereas for a bituminous coal 5 hr. was sufficient. Fig. 2 shows the spectra so obtained from five coals, each predominantly vitrain, of ash content less than 1·5 per cent, covering the range from class 100 (anthracite) to class 900 (bituminous). The spectra were recorded on a Grubb–Parsons infra-red spectrometer using a sodium chloride prism. A detailed interpretation of these spectra will be reported elsewhere in due course, but a few general observations follow.

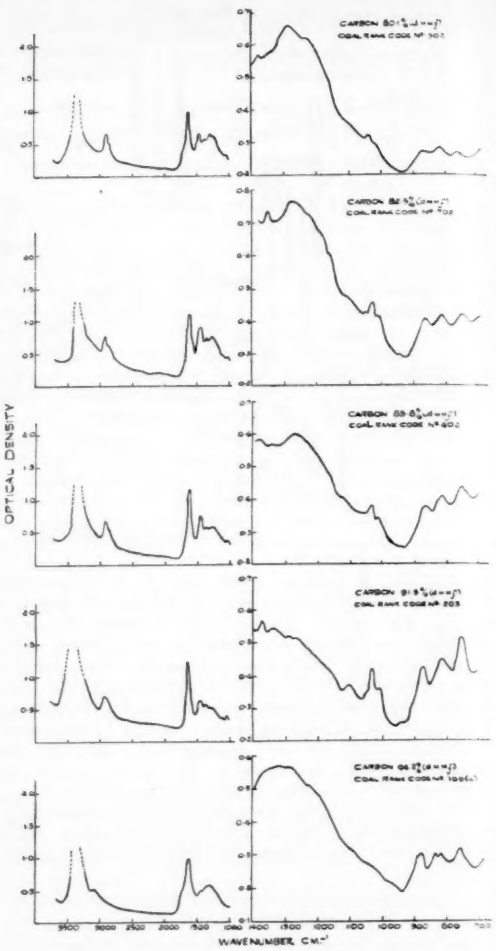

Fig. 2. Infra-red spectra of coals of different rank

The sample disks of all the coals contain the same amounts of coal and potassium bromide (weight of disk 350 mgm., thickness of disk 1·5 mm., coal percentage 0·5) and the spectra may be compared one with another on a reasonably accurate quantitative basis. This represents a considerable improvement on the 'Nujol' technique, where comparison between spectra was only qualitative.

It may therefore be stated that there is little variation in the general level of absorption throughout the range of coals in Fig. 2. The contrary assertion, that the general level of absorption

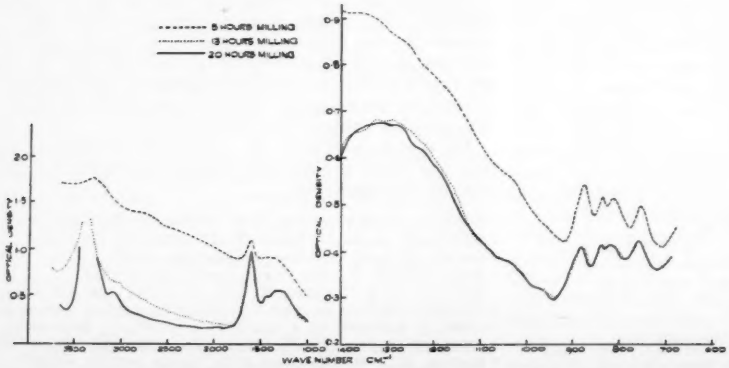

Fig. 1. Infra-red spectra of anthracite and effect of milling-time

rises with the carbon content, has previously been made[5,6], on the evidence of spectra derived from 'Nujol' mulls. It now appears that what was interpreted as a high general level of true absorption in the anthracites was actually a high degree of scattering, caused either by inadequate grinding or by subsequent aggregation of particles in the suspension.

The regions of the spectra about 2,850, 1,450 and 1,370 cm.$^{-1}$, which are obscured by the paraffinic CH absorptions from 'Nujol', are now observable. On the other hand, we have found it necessary to record the spectrum fairly soon after a disk is made, because disks which have been stored for some time show additional absorption peaks at 1,110, 1,043, 997 and 918 cm.$^{-1}$, the intensities increasing with time. The cause of this phenomenon is being sought.

Thanks are due to the National Coal Board for permission to publish this communication.

R. R. Gordon
W. N. Adams
G. J. Pitt
G. H. Watson

National Coal Board,
Central Research Establishment 1,
Stoke Orchard, Glos. Oct. 8.

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Heats of Reaction during Carbonization as deduced from Temperature Surveys of a Coke Oven

Metallurgical coke is made by carbonizing coal in an oven that consists essentially of two heated walls spaced some 40–45 cm. apart. Coal is charged into the already heated oven, and the isotherms in the coal are found to be substantially pairs of planes parallel to the oven walls. With the passage of time, both components of any pair of isothermal planes will advance through the charge to the centre of the oven. As the dimensions of the walls are large with respect to their spacing, the system may be regarded for the purpose of analysis as one-dimensional and, if the thermal properties of the charge are known, the temperature distribution at any time should be determinable by solution of the one-dimensional case of the heat-flow equation.

This was attempted for the case of a 10-cwt. experimental coke oven charged with three different coals. Temperature histories were recorded for different points across the oven, and the thermal properties of the coals used were measured in the laboratory. Thermal conductivities showed large changes with temperature (Fig. 1), but the product of density and specific heat showed only relatively small (10 per cent) changes during carbonization.

Numerical solution of the heat-flow equation using the experimental data would have been exceedingly tedious, so an analogue method of solution due to Liebmann[1] was used. In this method time is treated in iterative steps, the solution over each time-interval being obtained from an electrical resistance analogue in which the electrical parameters (conductance, voltage, etc.) are adjusted to correspond to the values appropriate to the thermal parameters (conductance, temperature, etc.) for that step.

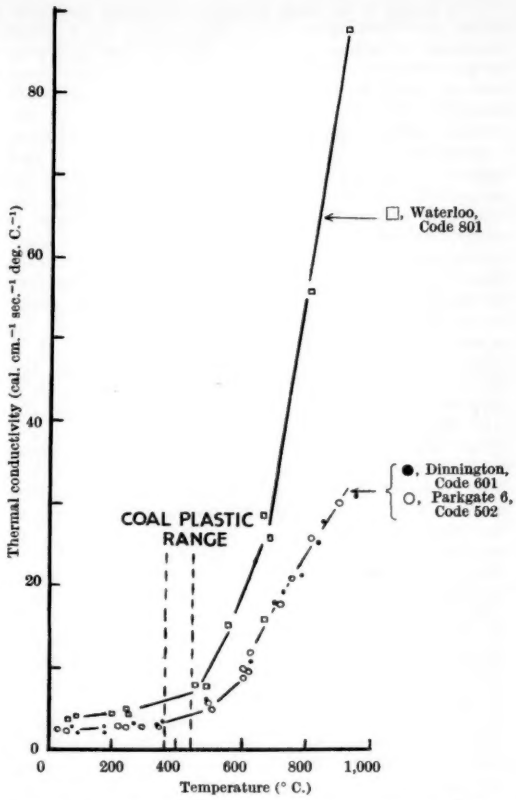
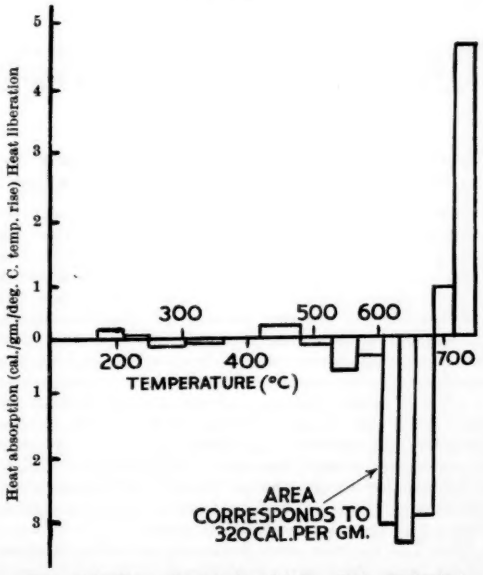


Fig. 1. Thermal conductivity as a function of temperature for the three coals used



Rate of heating: about 3 deg. C./min. Coal: Parkgate 6, N.C.B. Code 502

Fig. 2. Heat of reaction in cal. per gm. per deg. C. temperature rise as a function of temperature for a coking coal (Parkgate 6)

It is found in all cases that the calculated temperatures are first higher, but later lower, than those observed experimentally, the change-over occurring at about 740° C. These discrepancies are larger than can be explained by gas convection or radiation effects in the coke oven, and are believed to be due to the carbonization process being on the average endothermic below a temperature near 700° C. and exothermic above this temperature. To estimate the magnitude of the heat absorption/liberation, the analogue computing technique due to Liebmann is sufficiently flexible to be used in reverse. The computer was made to follow the observed temperature histories and note was taken of the heat absorption/liberation that had to be postulated in order to make it do this. A typical result of such a calculation for a rate of heating of 3 deg. C. per minute is shown in Fig. 2. It was found that heat is absorbed in the range 150°–700° C. Of the three coals tested, Parkgate 6 absorbs 320 cal. per gm., Dinnington absorbs 170 cal. per gm. and Waterloo absorbs 780 cal. per gm. Above 700° C. all three coals are exothermic, releasing some hundreds of calories per gm. between 700° and 800° C. The calculation could not be carried beyond 800° C. owing to difficulties in experimental technique, but two of the coals (Parkgate 6, Dinnington) are known to be still exothermic above 900° C. This was seen from the experimental temperature surveys, which show that at about 900° C. the temperature throughout the oven becomes uniform, and at this point the temperature at the centre is still rising above that of the outside at a rate of about 0·3 deg. C. per min., eventually becoming some 50 deg. hotter than the walls.

I wish to thank the Director General of Research, National Coal Board, for permission to publish this communication. The views expressed in it are my own and not necessarily those of the Board.

D. J. Millard

Central Research Establishment 1,
National Coal Board, Stoke Orchard,
Cheltenham. Aug. 18.

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'Reaction Time' of Cast Trinitrotoluene as a Function of the Rate of Charge Cooling

For charge diameters greater than 1 in., the detonation velocity of 'confined' T.N.T., that is, T.N.T. cast in metal tubes, increases only very slightly with increasing charge diameter, indicating a very short reaction-time ($\sim 10^{-8}$ sec.) for the primary decomposition process of this explosive. The experimental results already reported[1] suggested that this small change might be associated with the existence of the 'surface chilled' layer which would be present in all heavily confined charges and would vary little in character with changes in charge diameter. It was decided, therefore, to re-investigate the velocity – charge diameter relationship for T.N.T. under conditions of charge cooling such that very different degrees of surface chilling were operative during the initial solidification phase.

The T.N.T. was cast in heavy seamless copper tubing with internal diameters of 1½ in., 2 in. and 3 in. using the following two casting techniques:

(1) *Ordinary 'clear cast' T.N.T.* Molten T.N.T. at 105° C. was poured into the cold casing and allowed to cool without interruption at room temperature. Casting-heads were employed, so that stirring during solidification could be dispensed with but cavitation effects avoided.

(2) *Ordinary 'clear cast' T.N.T. in heated cases—slow cooled.* The casings were first heated to 80–85° C. in a large steam-heated vessel. The T.N.T. at 105° C. was then poured in so as to fill completely the charge casing and casting-head, the steam turned off, the vessel covered and the charge then allowed to cool. Because of the large heat capacity of the containing vessel, cooling was very slow, complete solidification requiring 4–6 hr.

The degree of confinement (S) was maintained constant at the various diameters ($S = 3{\cdot}10$–$3{\cdot}28$ gm./sq. cm.). Two velocities were measured on each charge over 30 cm. intervals using the Dautriche[2] method, commencing at distances of 10 cm. and 20 cm. from the initiated end. This staggering of the timing intervals afforded a rough check on the stability of the detonation velocity along the charge. The results obtained are summarized in Table 1.

Table 1

Charge diameter (in.)	Density, Δ (gm./c.c.)	Type of cooling	Average velocity of detonation (m./sec.)
1	1·58	Ordinary	6,760
1	1·57	Slow	5,900
1½	1·59	Ordinary	6,710
1½	1·58	Slow	6,280
2	1·59	Ordinary	6,845
2	1·57	Slow	6,480
3	1·56	Slow	6,480

A much greater scatter among individual results was evident with the slowly cooled charges, as might be expected since uniformity of crystal size and orientation are more difficult to ensure from one charge to the next.

If U is the observed detonation velocity and R the charge radius, plots of $1/U^2$ against $1/R$ are approximately linear for both cooling rates, and on the basis of the theoretical treatment of Jones and Stickland[3] the slopes of these lines lead to estimates of the effective reaction-time for the two types of charges, that is, to the time occupied by the primary decomposition process that determines the extent to which lateral energy losses may occur, and hence the detonation velocity. The slowly cooled charges show a ten-fold increase in reaction time. The two lines obtained in the present experiments are but two representatives of an infinite number of possibilities between certain limits. Theoretically, these two limits are on one hand liquid T.N.T. in which the 'crystallites' are of molecular dimensions, and on the other hand a charge consisting of a single large crystal, in which case the reaction-time would probably be so long that the term detonation would no longer be applicable.

It is well known that the grain size of T.N.T. increases with decreased rates of cooling, and while the possibility of changes in crystal orientation must be borne in mind, in the absence of any direct evidence to show that such changes may significantly affect the velocity of detonation, it seems logical to relate the changes in reaction-time to changes in grain-size, the reaction-time decreasing as the internal surface is increased.

It appears that in cast-confined charges there is at the surface a fine-grained outer layer with a higher intrinsic detonation velocity (that is, shorter reaction

time) than the core. The situation is somewhat akin to a composite charge composed of cylinders of different detonation velocities. The detonation velocity is then always that of the component with the highest detonation velocity, and whether the high-velocity component is on the outside or the inside it will still be the rate-determining factor for the charge as a whole. In the case of confined charges, the finely crystalline surface-chilled layer is probably very thin, and the effect produced, therefore, may be of an intermediate character; but it will be out of all proportion to its size because it is the high-velocity component.

The dependence of reaction-time on grain-size in the case of cast explosives has an important bearing on the various theories put forward to account for the initiation of the decomposition at the detonation front. It is in accord with the hypothesis of heterogeneous explosive decomposition involving a reaction between a gaseous and a solid phase, the major part of the reaction involving the erosion of the crystallites by the hot gases arising from the already decomposed explosive.

We acknowledge our thanks to the Chief Scientist, Ministry of Supply, for permission to publish these results. This work was carried out during the latter years of the Second World War.

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Aug. 18.

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Oxidation Changes in Natural Ilmenite

Nagata has discussed the occurrence of three magnetic components of the Haruna and Asio rocks exhibiting thermo-remanent reversals[1]. The properties of the *B*-component appear to be very similar to those of a material recently examined in this laboratory. We have been investigating the impure ilmenite concentrate obtained as a by-product in the winning of rutile from beach sands on the east coast of Australia.

This concentrate may be refined magnetically to produce a highly magnetic fraction (containing magnetite and other highly magnetic materials and comprising about 2 per cent by weight of the total concentrate) together with fractions of weakly ferromagnetic material closely related to ilmenite which have volume magnetic susceptibility in the range $0{\cdot}4 \times 10^{-3}$ to $1{\cdot}1 \times 10^{-3}$ c.g.s.u. at low magnetizing fields. This variation in susceptibility is associated with a variation in apparent ferric to ferrous iron ratio, the range being 0·40–0·65, while the titanium (TiO_2) content is within the range (50 ± 2) weight per cent. Manganese is present to about 2 per cent by weight.

When any magnetic fraction of this 'ilmenite' is heated in air at a temperature in excess of 600° and below 800° C., an oxidation process occurs during which the apparent ferric to ferrous iron ratio rises to approximately 1·3 and, on cooling, the material shows much enhanced magnetic properties. The value of the initial susceptibility for a sample of firmly packed grains is approximately 2×10^{-3} c.g.s.u., about one-fifth of that for a similar sample of natural magnetite.

Observations have been made of the crystal structure and magnetic properties of this 'magnetic ilmenite' derived from different magnetic fractions of the original ilmenite, and no significant variation has been noted. Debye–Scherrer X-ray photographs were made for a particular fraction of the ilmenite and for the 'magnetic ilmenite' derived from this fraction, and these were compared. The pattern due to 'magnetic ilmenite' may be described as the superposition of a set of lines which were indistinguishable from the lines of the original fraction and of lines due to rutile. No difference has yet been noted by mineragraphic examination of the two sets of grains.

The Curie point of the 'magnetic ilmenite' is between 100° and 200° C., and the dependence on temperature of the magnetic properties is otherwise consistent with that for Nagata's *B*-component[1b].

Qualitative tests show that crystals of Norwegian ilmenite may similarly be changed to 'magnetic ilmenite', but the necessary temperature and time of heating will depend on the size of the crystals.

Prolonged roasting of the natural ilmenite at temperatures in excess of 800° C. results in the conversion of the iron to the ferric form. The final product is weakly ferromagnetic, and at low magnetizing fields the volume magnetic susceptibility is about $0{\cdot}3 \times 10^{-3}$ c.g.s.u. The Debye–Scherrer X-ray pattern may be resolved into a set of rutile lines and a set of lines due to a tetragonal crystal with lattice parameters $a = 4{\cdot}861$ A., $c = 6{\cdot}625$ A., $c/a = 1{\cdot}363$.

This investigation has been carried out in the J. I. Carroll Research Laboratory of this School and we wish to acknowledge the guidance of Prof. C. J. Milner.

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Flow Potentials in Hyaluronate Solutions

Recently, it was found in this Institute[1] that solutions of potassium hyaluronate give elastic recoil when examined in a glass capillary by the 'œstroscope' technique[2]. This was ascribed to the long, flexible hyaluronate ions, which presumably form a lace-work all through the solution, knitted together by hydrogen-bond cross-links and adhering to the glass wall. The potassium ions are obviously more free to move, but in flowing, as soon as they tend to run in advance of the negatively charged hyaluronate polyions, a potential must arise to preserve electroneutrality.

In connexion with another recent finding in this Institute, that the endolymph of the inner ear in sharks contains a fair amount of hyaluronic acid[3], the possible occurrence of such flow potentials in hyaluronate solutions opened up an interesting possibility to account for the microphonic potentials detected in the inner ear by Wever and Bray[4] and thereby also to contribute to our understanding of the mechanism of perception in the inner ear.

To test the actual occurrence of such potentials we made a primitive model. From a screened capillary

U-tube in which a column of 0·5 per cent hyaluronic acid solution could be moved by gentle suction and blowing, the potentials between silver – silver chloride electrodes dipping through the two surfaces were led to the symmetrical d.c. input of a cathode ray oscillograph (*OSG* 41, Radiometer, Copenhagen; input impedance 1 MΩ).

In this way potentials of 6–10 mV. were obtained, positive at the advancing surface and persisting until the liquid is allowed to return towards its original position. In special cases much higher potentials (20–25 mV.) were found: namely, at the first displacement after filling with fresh solution, and when after blowing out the bulk of the solution we filled the tube with water, which slowly dissolved the adsorbed film. With pure water, and also with a 10 per cent gum arabic solution, potential shifts during the same manipulations were equal to or less than the noise-level of 1–2 mV.

A more detailed study of the potentials is planned, and we also hope in a later publication to give a detailed discussion of the significance of these potentials in connexion with the function of the inner ear.

We are indebted to the head of this Institute, Prof. J. A. Christiansen, for his interest in this work.

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Thure Vilstrup

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Sept. 2.

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Protective Effect of *d,l*-α-Octadecylglycerol-ether in Mice given Total Body *X*-Irradiation

Sandler[1] claimed that the protective factor against benzene poisoning found in yellow bone marrow is batyl alcohol or one of its esters. Since batyl alcohol is found in those organs which are said to contain a humoral factor that protects animals against the acute phase of irradiation injury[2], the following experiments were carried out. Sixty adult white male mice of an inbred strain (16 years) were irradiated with a therapeutic X-ray machine, 165 kV., 15 m.amp., filters 0·5 mm. copper + 1 mm. aluminium, target distance 60 cm., irradiation time 25 min., total dose 750 r. (air). Two hours after the end of the irradiation, thirty animals chosen at random were given 0·1 ml. of peanut oil subcutaneously, the others the same volume of peanut oil containing 2·5 mgm. *dl*-batyl alcohol per ml. These injections were repeated every second day until 1·75 mgm. of *dl*-batyl alcohol or a corresponding amount of the solvent had been administered to the animals. The 30-day letbality for the animals treated with batyl alcohol was seventeen out of thirty and for the controls twenty-six out of thirty. The difference is statistically significant ($P < 0·01$).

I have tried to find the optimal dosages for the synthetic alcohol and then for the naturally occurring alkoxyglycerol esters. From these experiments it can be concluded that in certain circumstances both these agents have a beneficial therapeutic effect on irradiation injury in mice; overdosage, however, increases the lethality. Further studies are in progress.

Simultaneously, but independently, Brohult *et al.* [following communication] have studied the effect of alkoxyglycerols in the treatment of leukopænia caused by irradiation.

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Alkoxyglycerols in the Treatment of Leukopænia caused by Irradiation

During irradiation therapy the blood-forming tissues are subjected to a great strain. At first this becomes noticeable in the form of a decreased white-cell count. This leucopænia sometimes necessitates an interruption of the irradiation therapy and consequently the time of treatment of the patient is prolonged.

Since the autumn of 1953, we have administered *per os* α-alkoxyglycerol preparations to some patients treated with irradiation. The alkoxyglycerols and particularly their esters are present in the lipids of several animal organs. One of the alkoxyglycerols, namely, batyl alcohol, is found in, for example, bone marrow fat[1], it forms part of the 'non-saponifiable' spleen lipids[2], and in the red cells[3]. It is also found in the liver lipids, and particularly in the liver lipids of sharks. Its presence in the red cells and in blood-forming organs is noteworthy.

The idea of administering extracts of erythropoietic tissues in disorders in the erythropoietic process is not new. Thus Marberg and Wiles[4] reported that the non-saponifiable portion of yellow bone marrow fat from cattle was effective in the treatment of agranulocytosis and leukopænia. Later Sandler[5] studied the erythropoietic effect of yellow bone-marrow extracts as well as batyl alcohol. Sandler states that a definite response in the reticulocyte count was obtained when batyl alcohol was administered orally to normal subjects.

We examined the effect in 1952 of giving the non-saponifiable portion of bone fats *per os* to some cases of leukæmia in children. We then continued with other preparations containing alkoxyglycerols and their esters in the form of concentrates. These concentrates had a higher potency than the bone-marrow preparations. The observations from some of these cases form the background of the experiments reported here.

To patients suffering from irradiation leukopænia, alkoxyglycerol esters were administered *per os* while the irradiation was continued. So far thirty-six cases have been studied. Of these, twenty-five responded to the therapy by an immediate increase in the white-cell count. In nine cases there was no further decrease in white cells after starting therapy. Only two cases showed a continued decrease in leucocytes.

A striking effect is illustrated by the following observations during the treatment of a nurse who had been occupied in radium therapy for some years. She had for more than a year a white-cell count of about 2,000 and was treated for five days with an alkoxyglycerol ester concentrate *per os* as the only therapy. Already after four days a white-cell count

of 3,600 was reached. After withdrawal of medication, this level was maintained for five months with only one additional four-day treatment. A third period of four days of therapy followed after five months and resulted in a white-cell count of 4,200. Treatment for a few days obviously maintained the white-cell count on a normal level for a long period.

We thus conclude that treatment *per os* with alkoxyglycerols as well as their esters is a promising therapy against leukopænia caused by irradiation. The alkoxyglycerols might also give a more general protection of the blood-forming tissues against irradiation damages. A more detailed study of this subject, as well as of other effects of the alkoxyglycerols, will be published elsewhere.

Simultaneously, but independently, Edlund has studied the protective action of batyl alcohol on irradiated mice [see preceding communication].

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Exchange of ^{14}C-Glucose-1-phosphate with Uridine-diphosphate-glucose by the Galacto-Waldenase System

A TWO-STEP reaction, as represented by reactions 1 and 2, has been proposed[1] for the enzymatic transformation of galactose-1-phosphate into glucose-1-phosphate :

$$\text{Gal-1-P} + \text{UDPG} \rightleftharpoons \text{G-1-P} + \text{UDPGal} \quad (1)$$

$$\text{UDPGal} \rightleftharpoons \text{UDPG} \quad (2)$$

Reaction 2 has been experimentally demonstrated[1]. Kalckar *et al.*[2] have recently reported as evidence for the occurrence of reaction 1 the formation of 1 mol. of glucose-1-phosphate per mol. of uridine-diphosphate-glucose and of galactose-1-phosphate consumed, when these two compounds are incubated with diluted *Saccharomyces fragilis* extract.

If the proposed mechanism is correct, incorporation of carbon-14 glucose into the uridine-diphosphate-glucose should occur when this compound and ^{14}C-glucose-1-phosphate are incubated with *S. fragilis* extract. The experiments reported here have shown this to be the case.

Since phosphoglucomutase is present in the crude *S. fragilis* extracts, ^{14}C-glucose-1-phosphate could be replaced by ^{14}C-glucose-6-phosphate. This was prepared by incubation of glucose labelled uniformly with carbon-14 plus adenosine triphosphate with partially purified yeast hexokinase. A preparation purified by the method of Berger *et al.*[3] up to step 4 was used. ^{14}C-glucose-6-phosphate was precipitated as barium salt, which was then dissolved and re-precipitated with barium and alcohol. A preparation devoid of reducing power and inorganic phosphate was obtained.

^{14}C-glucose-6-phosphate and uridine-diphosphate-glucose were incubated with dialysed *S. fragilis* extract under the conditions specified in Table 1. The reaction was stopped by adding to the incubated mixture four volumes of alcohol and 0·02 ml. of *M* acetic acid solution. The protein precipitate was centrifuged and washed twice with 70 per cent alcohol. Supernatants and washings were mixed and the resulting solutions evaporated *in vacuo* to dryness. The residues were taken up in distilled water, deposited on a sheet of Whatman No. 1 filter paper, and chromatographed with the acid ethanol–ammonium acetate solvent[4]. Areas on the paper carrying the equilibrium mixture of uridine-diphosphate-glucose (75 per cent) and uridine-diphosphate-galactose (25 per cent) were located by ultra-violet light and eluted with distilled water. The amount of this equilibrium mixture in the samples was determined by measuring the absorption of an aliquot at 260 mμ in a Beckman spectrophotometer. The carbon-14-labelled equilibrium mixture was determined by measuring the radioactivity of an aliquot evaporated on an aluminium disk, with a thin mica end-window Geiger–Müller tube and a 'Tracerlab' scaler. As is shown in Table 1, after 30 min. of incubation, the radioactivity of glucose-6-phosphate was equilibrated with that of the above equilibrium mixture. The small amount of radioactivity found in the latter incubated without uridine-diphosphate-glucose must be due to the presence of small amounts of this compound in the dialysed extract.

When in the experiment described in Table 1, ^{14}C-glucose-6-phosphate was replaced by ^{14}C-glucose, no radioactivity was incorporated into the uridine-diphosphate-glucose.

Kalckar *et al.*[5] demonstrated the occurrence in *S. fragilis* extracts of reaction 3, catalysed by a specific pyrophosphorylase, which has been named 'uridyl transferase'[5] :

$$\text{UDPG} + \text{PP} \rightleftharpoons \text{G-1-P} + \text{UTP}. \quad (3)$$

The incorporation of ^{14}C-glucose into uridine-diphosphate-glucose might alternatively be explained by the reversal of reaction (3), were it not for the fact that in the absence of uridine-tri- or di-phosphate and adenosine triphosphate[6], a condition fulfilled by the dialysed extract, this mechanism is not operating. Thus our results are in favour of the mechanism represented by reactions 1 and 2.

Table 1. INCUBATION OF ^{14}C-GLUCOSE-6-PHOSPHATE AND URIDINE-DIPHOSPHATE-GLUCOSE WITH *S. fragilis* EXTRACT

Incubation at 37° C. of 0·33 μM of ^{14}C-glucose-6-phosphate of specific activity 5,910 counts/min./μM, 0·01 μM of glucose-1,6-diphosphate, 0·3 μM of uridine-diphosphate-glucose and 2 μM of magnesium ions with 0·01 ml. of dialysed *S. fragilis* extract

Mixture	Incubation time (min.)	Spec. activity UDPG glucose counts/min./μM	Spec. activity UDPG glucose (exp.) / Spec. activity glucose-6-phosphate equilibrated with UDPG (calc.)
Without uridine-diphosphate-glucose*	30	290	0·09
Complete	30	2,910	0·98
Complete	60	2,400	0·81

* UDPG added after the enzyme was inactivated

On the basis of the exchange experiment, a procedure was developed for the preparation of the equilibrium mixture of uridine-diphosphate-glucose and uridine-diphosphate-galactose with its hexose moieties uniformly labelled with carbon-14. As hexokinase is present in the *S. fragilis* extract, ^{14}C-glucose-6-phosphate could be replaced by ^{14}C-glucose and adenosine triphosphate. The equilibrium mixture was separated by chromatography on Whatman No. 3 filter paper using ethanol – ammonium acetate as developer, and was eluted with distilled water from the corresponding area and rechromatographed with methanol – formic acid[7]. When this rechromatographed product was chromatographed with ethanol – ammonium acetate, it gave only one spot showing absorption in the ultra-violet and radioactivity.

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Alternate Pathways of Glycerol Oxidation in *Acetobacter suboxydans*

A previous publication from this laboratory[1] has reported in detail the rapid oxidation of glycerol to dihydroxyacetone by resting whole cells of *A. suboxydans* 621, at *p*H 6·0. This conversion proceeds more slowly beyond the dihydroxyacetone stage. In cell-free extracts with triphenyltetrazolium chloride as the electron acceptor, glycerol is oxidized at a rate comparable to the oxidation of dihydroxyacetone, with the *p*H optimum about 8·5. This contrasting behaviour has been found to be due to the presence of two major oxidative routes for glycerol oxidation, one phosphorylative, the other independent of phosphate, as shown in Table 1. With cell-free extracts at *p*H 8·5, adenosine triphosphate is obligatory (in kinase systems) not only for the oxidation of glycerol but also for dihydroxyacetone, glucose, ribose or erythritol.

The pathway of dihydroxyacetone oxidation has been examined further, and found to possess the characteristics common to the Horecker pentose cycle[2], as follows: (1) Formation of dihydroxyacetone phosphate must first take place, either from glycerol-α-phosphate or from dihydroxyacetone plus adenosine triphosphate[3]. (2) Dihydroxyacetone phosphate is then converted through isomerase and aldolase to fructose diphosphate. (3) The latter loses one mole of phosphorus in the presence of magnesium to yield an acid-stable phosphate, presumably fructose-6-phosphate. (4) The latter reaches equilibrium with glucose-6-phosphate as measured by the resorcinol test[4] in the reverse reaction; (5) either of these compounds, when added, is oxidized by triphenyltetrazolium chloride and either tri- or di-phosphopyridine nucleotide to a material that gives a positive orcinol-pentose reaction. (6) Ribose-5-phosphate is converted non-oxidatively to sedoheptulose, triose and hexose derivatives in the amounts given in Table 2. The oxidative cycle is thus closed, with an expected *R.Q.* of 1·0 for dissimilation of dihydroxyacetone. This *R.Q.* has been obtained both in resting cells[5] and in the present cell-free extract.

Table 1. Phosphorylative and Non-phosphorylative Oxidation of Glycerol

ATP	Q_{O_2}					
	*p*H 6·0			*p*H 8·5		
	Whole cells	Cell free extract*		Whole cells	Cell-free extract*	
	Oxygen	Oxygen	Triphenyltetrazolium chloride	Oxygen	Oxygen	Triphenyltetrazolium chloride
−	10	23	0	0·6	0	0
+	10	23	0	0·6	12	9

* Cell-free extract; total soluble fraction, prepared as described previously (ref. 11).

Each Warburg vessel contained 50 μmol. malate buffer at *p*H 6·0 or 100 μmol. tris(hydroxymethyl) aminomethane (tris) at *p*H 8·5, 5 μmol. magnesium chloride, 0·2 ml. 20 per cent potassium hydroxide in the centre well. Concentration of adenosine triphosphate was 1 μmol./ml. wherever used. The whole-cell experiments contained in addition 40 μmol. glycerol, 10 mgm. cells (dry weight) and water to 3 ml. 3 μmol. diphosphopyridine nucleotide was added together with adenosine triphosphate at *p*H 8·5. The cell-free extract experiments with oxygen had 30 μmol. glycerol, 20 μmol. sodium fluoride, and 1 ml. cell-free extract in a total volume of 2 ml. The atmosphere was air. The tubes in the triphenyltetrazolium chloride experiments were incubated *in vacuo* with 5 μmol. glycerol, 50 μmol. tris, 10 μmol. sodium fluoride, 2·5 μmol. magnesium chloride, 5 μmol. triphenyltetrazolium chloride, 0·1 μmol. diphosphopyridine nucleotide and 0·1 ml. cell-free extract in a total volume of 1 ml.

Q_{O_2} for whole cells = μatoms oxygen/mgm. dry cells/hr.; for cell-free extract = μatoms oxygen, or μmol. triphenyltetrazolium chloride/ml. cell-free extract (27 mgm. dry weight, 18 mgm. protein)/hr. Time intervals used to compute Q_{O_2} (usually 20–40 min.) were sufficient to permit conversion of up to 20 per cent of the added glycerol to dihydroxyacetone.

The pentose cycle thus appears to operate *in toto* in at least one microbial system, as well as in animal tissues[8] and plants[7]. Additional presumptive evidence for its presence in yeast[8] and *Escherichia coli*[5,9] is available, and preliminary observations in this laboratory indicate that this group of reactions may function in wheat smut fungi and pea aphids[10]. In

Table 2. Non-oxidative Breakdown of Ribose-5-phosphate by Cell-free Extract

Time (min.)	0	2	5	20	80
Sugar	μmoles sugar				
Pentose	10·0	8·9	7·3	4·4	0·8
Hexose	0·0	0·0	1·1	2·6	4·7
Sedoheptulose	0·0	0·4	0·7	0·9	0·6
Triose-phosphate	0·0	0·5	0·6	0·6	0·8
Total*	10·0	9·8	10·0	9·1	7·8

* Values for total sugars are given as pentose equivalents (μmol. carbon/5).

The tubes were incubated *in vacuo* with 10 μmol. ribose-5-phosphate, 100 μmol. tris buffer at *p*H 8·0, 20 μmol. sodium fluoride, 0·15 ml. cell-free extract and water to 2 ml. The reaction was stopped by adding 1·6 ml. of 10 per cent trichloroacetic acid. Pentose was assayed in the reaction mixtures according to Mejbaum (ref. 12), hexose and sedoheptulose with the sulphuric acid–cysteine reaction (ref. 7), and triose-phosphate as alkali-hydrolysable phosphate. Magnesium was omitted.

Acetobacter, however, the cycle is overshadowed during growth by the non-phosphorylative oxidation described above, which accumulates dihydroxyacetone more rapidly than it can be metabolized. Details of these and related oxidations in this organism will be presented elsewhere.

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Mechanism of the Formation of Red Melanin in the Silkworm

THE body-fluid of a mutant of the silkworm called 'Aka-Aka' (*rb*), which was discovered by me[1], turns red when exposed in the air, and the abnormal colouring of this mutant was supposed to be due to abnormal accumulation of 3-hydroxykynurenine[2]. I have recently investigated the mechanism of formation of this red colouring material.

Investigation by absorption spectroscopy and the relation of the decolorization to the reduction of the red colouring material proved that it was not a hallachrome, which is a red substance derived from tyrosine. Stepwise investigation of ultra-violet absorption spectra of the *rb* body-fluid during the course of the change of colour indicated that the absorptions at 270 mμ and 370 mμ which are characteristic of 3-hydroxykynurenine decreased and the whole absorption curve came to show the characteristics of melanin. Quantitative determinations of 3-hydroxykynurenine in the same samples by the diazo-oxide method[3] also indicated that the decrease of 3-hydroxykynurenine was parallel with the increase of red pigment.

The amounts of 3-hydroxykynurenine in the body-fluid obtained by crossing, for example, in *rb*/*rb* and +/+, were found to be 880 and 38 γ/c.c. respectively.

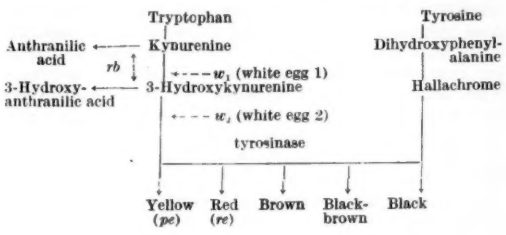
From the above facts, it will be clear that the body-fluid of silkworms turns red as 3-hydroxykynurenine accumulates in it, whereas it turns black if the amount of kynurenine is small. This conclusion was also affirmed by an *in vitro* test, in which the normal type body-fluid turned black when exposed to air; it turned red when 3-hydroxykynurenine was added.

Following up this idea, I have prepared melanin dyes of various colours from dihydroxyphenylalanine, 3-hydroxykynurenine and tyrosinase (potato) as follows:

Dihydroxy-phenylalanine	3-Hydroxy-kynurenine	Tyrosin-ase	Colour	Pre-cipitation
+	−	+	black	+++
2 mol.	1 mol.	+	black-brown	++
1 mol.	1 mol.	+	red-brown	+
0·5 mol.	1 mol.	+	red	±
0·25 mol.	1 mol.	+	red	−
—	+	+	yellow	−

While the increase of dihydroxyphenylalanine resulted in a black colour, 3-hydroxykynurenine produced a reddish colour.

Thus the mechanism of the formation of colouring materials in silkworm could be explained according to the following scheme, and the same mechanism can be applied to the formation of egg colour in the mutants called 'pink egg' (*pe*) and 'red egg' (*re*).



The absorption spectra were kindly measured by Dr. K. Ueno, of Dojindo and Co., Ltd.

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Primycin, a New Antibiotic

FROM the intestinal tract and the fæces of a strain of the larvæ of the wax moth (*Galeria melonella*), a micro-organism producing an antibiotic has been isolated. Morphologically, it belongs to the *Actinomycetes*, grows readily and spores abundantly on slightly alkaline nutrient agar, potato agar and asparagine agar, with an optimal yield of the antibiotic in a liquid medium containing 2–4 per cent corn-steep liquor and 1 per cent glucose. At 37° C. a surface culture on the latter medium begins to produce the antibiotic on the third day, with a maximal yield from the sixth to the ninth days. During growth the initial *p*H 7·4–7·6 of the medium rises to 8–8·5, accompanied by a steady decrease of carbohydrate and nitrogen concentration. At the peak of production a rapid lysis of mycelium takes place; but on further incubation the antibiotic concentration of the medium is not reduced.

The growth of *Staph. aureus* D. in a medium containing 5 ml. casein hydrolysate is inhibited by 0·01–0·03 ml. of the samples taken from surface cultures six to eight days old, diluted 1 to 10. Submerged cultures give an average yield somewhat below this level. On acidifying the filtrate of fermentation fluid (*p*H 2·5–2·8), a voluminous precipitate is formed which adsorbs the active substance to its surface almost quantitatively. The precipitate may be dried without loss of activity; its aqueous suspension is active at concentrations of 3–20 μgm. per ml. The substance is thermostable. The crude product contains 8–10 per cent ash, lipids and other organic substances, nitrogen 10–12 per cent, which can be removed by ether extraction. The active substance may be transferred quantitatively from the extraction residue to dry methanol, together with considerable pigment and inorganic phosphate impurities, which can be adsorbed with colloidal aluminium hydroxide. The active substance can be separated by adding ether to this partly purified and concentrated methanol solution. Solutions of this crude product inhibit the growth of *Staphylococcus aureus* D. in concentrations of 0·1–0·3 μgm. per ml. This crude product contains 5–32 per cent ash and 1·6–3·5 per cent nitrogen.

Further purification of this crude preparation was carried out by dissolving the precipitate in 20 per cent methanol and extracting this mixture repeatedly with butanol. The active substance was prepared by precipitation of the collected butanol extracts with ether. The effectiveness of the substance on this level of purity corresponds to 0·05–0·07 μgm./ml. By repeating this treatment further purification of the substance may be obtained, but the preparation still contains pigments in small amounts and 0·0–0·4 per cent ash. The active substance ('primycin') forms white micro-crystals when crystallized from methanol–butanol and melts at 166–168° C. with decomposition; analysis: C, 58·79; H, 9·56; N, 3·63 (Dumas); N, 3·58 per cent (Kjeldahl). These results correspond with the empirical formula $C_{19}H_{37}O_7N$, giving a molecular weight of 391·5. Ebullioscopic determination of molecular weight gave 329·9 (in methanol). The active substance has no characteristic absorption maximum either in the visible or in the ultra-violet region.

Primycin is fairly soluble in methanol (2·5 per cent), less soluble in higher alcohol homologues, sparingly soluble in pyridine, glacial acetic acid and water (50 mgm. per cent) and insoluble in other solvents. Its aqueous solution is sensitive to electrolytes, thermostable, strongly surface-active and adsorptive. In concentrated sulphuric acid it dissolves, giving first a yellow, then a red colour. It does not reduce Fehling's solution, does not react with aldehyde reagents and gives the Brunner–Pettenkoffer reaction. In a pyridine medium it can be acetylated. The acetylated (in pyridine) substance is inactive, but regains full activity after splitting off the acyl groups. Solutions of the purest product obtained so far inhibit the growth of *Staph. aureus* Duncan in concentrations of 0·02–0·06 μgm. per ml. It has *in vitro* a bacteriostatic effect on Gram-positive organisms, both pathogenic and non-pathogenic, as well as on Mycobacteria. In this order of magnitude it affects resistant strains too. The presence of serum reduces its potency to a quarter to a fifth of the initial potency. Its activity is increased at alkaline and reduced at acid reaction, with an optimal *p*H in the range 7·6–7·8. *In vitro* it is non-toxic to tissue cultures. So far as can be judged at present, it has also viricidal effects. Toxicity: *LD* mice, 2·5 mgm./kgm.; *LD* rats, 10 mgm./kgm.; *DT* rabbits, 10 mgm./kgm. In the rabbit a dose of 5 mgm./kgm. intraperitoneally is still detectable in the serum six hours after administration. Since in animal experiments it appeared to be toxic, only superficial infections of man have been treated with it, but good results have been obtained. On the basis of its chemical and biological properties, primycin is not identical with any of the known antibiotics.

A detailed account of this investigation is to be published elsewhere.

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Adrenocorticotrophic Activity of Melanophore-expanding Hormone Preparations from Beef Pituitary Glands

Since it has been claimed recently that adrenocorticotrophic hormone and melanophore-expanding hormone are identical, we assayed several melanophore-expanding hormone preparations from beef pituitary glands for adrenocorticotrophic activity.

The assays were performed according to a modification of the procedure of Saffran *et al.*[1] on melanophore-expanding hormone preparations of different potencies (respectively 25, 75 and 150 times standard posterior pituitary powder) which were prepared by Stehle[2] (we are indebted to Prof. R. L. Stehle for putting his preparations at our disposal). These preparations were found to possess relatively little adrenocorticotrophic activity, but there is a correlation between the two activities.

Preparation	Melanophore-expanding potency (I.U./mgm.)	Adrenocorticotrophic potency (I.U./mgm.)	Range of adrenocorticotrophic potency (I.U./mgm.)	Ratio of melanophore-expanding to adrenocorticotrophic potency
1	50	0·024	0·015–0·039	2,080
2	150	0·065	0·034–0·126	2,310
3	300	0·167	0·106–0·241	1,800

The table lists the melanophore-expanding and adrenocorticotrophic activities of three melanophore-expanding hormone preparations. Preparation 1 was used as the starting material for preparation 2, which, in turn, was used to prepare 3. At the three stages of purification of the melanophore-expanding hormone, the ratio adrenocorticotrophic and melanophore-expanding activity remains essentially constant.

Our results show that potent preparations of melanophore-expanding hormone contain only traces of adrenocorticotrophic activity, so that it is impossible to conclude that melanophore-expanding and adrenocorticotrophic activities are entirely shared by the same molecule. The constancy of the ratio of the adrenocorticotrophic potency to the melanophore-expanding activity upon purification does not rule out the possibility that adrenocorticotrophic hormone is present as an impurity in the melanophore-expanding hormone preparation, but it also strongly suggests

that melanophore-expanding hormone may possess some slight inherent adrenocorticotrophic activity.

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Salicyloylhydrazide: a Reagent of Wide Use in Organic and Histochemical Analysis

Present methods of demonstrating ketosteroids in tissues are generally regarded as being unsatisfactory. 2-Hydroxy-3-naphthoyl hydrazide[1] is the reagent most recently introduced for this purpose, yet it condenses only sluggishly with carbonyl groups and fails to distinguish between aldehydes and ketones. A number of phenolic hydrazides have since been tested. Of these, 2 : 4 dihydroxybenzoylhydrazide[2] is better in that it provides azo-hydrazones of different colours in the ketosteroid group[3], but it still lacks adequate condensing reactivity.

Salicyloylhydrazide[4] is at present under investigation, and the preliminary results now reported may prove of interest to workers both in histochemistry and in other fields. It has been found that the aldehydic salicyloylhydrazones fluoresce brilliantly in diverse colours under ultra-violet light, whereas the ketonic derivatives which have been studied exhibit a uniform dull blue fluorescence. Zinc acetate greatly intensifies the ketonic fluorescence, but has no appreciable effect on the fluorescence of the aldehydic derivatives. A similar but very much weaker reaction is obtained with cadmium salts. Neither the reagent nor the carbonyl compound separately shows any luminescence at low *p*H.

The colour and intensity of fluorescence of the salicyloylhydrazones may be further controlled in two fundamental ways: (1) chemically, by alteration of *p*H, by treatment with free halogens, and by chelation; and (2) optically, by using an instrument capable of offering a series of monochromatic beams of ultra-violet light of differing wave-lengths. Preliminary experiments, utilizing varying combinations of these two control procedures, indicate that it may be possible to devise a system capable of distinguishing individual components of a mixture of ketones.

Investigations have also been carried out to determine quantitatively the condensing reactivity of the reagent. In a typical experiment, dehydroepiandrosterone was condensed with salicyloylhydrazide in acetic acid solution and excess reagent removed by washing with dilute hydrochloric acid. The salicyloylhydrazone, in virtue of its being a phenol, was then converted to an indoaniline by coupling it with *p*-aminodiethylaniline (stabilized with sulphur dioxide), in the presence of periodic acid as oxidant. The intensely coloured blue-green indoaniline was extracted with ethyl acetate and the optical density read in an absorptiometer against a blank determination, using a suitable filter. A linear relation was found between the optical density and the amount of ketosteroid present over the range 5–50 μgm.

Quantitative estimation of ketosteroids by fluorimetry of the salicyloylhydrazones is being studied in order to achieve an analytical method of a more direct and simple character.

Although salicyloylhydrazide has been investigated in the first instance as a reagent for use in histochemistry, the indoaniline reaction for phenols and also the fluorescent reaction of zinc acetate with salicyloylhydrazones are obviously capable of much wider application.

In general, salicyloylhydrazide is superior to the previous hydrazides I have described[1,2] in respect of reactivity in condensation, in differentiating capacity and in lending itself to colorimetric determination of ketosteroids.

The detailed use of the foregoing procedures in histochemistry and in relation to the estimation of ketosteroids will be the subject of future communications.

I am grateful to Prof. J. Patterson for his guidance throughout and to Prof. R. J. Harrison and Dr. G. H. Bourne for histochemical facilities provided at the London Hospital Medical School. The optical experiments were carried out at the National Institute for Medical Research in conjunction with Mr. J. Smiles, to whom I am indebted for the special knowledge and advice he contributed.

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Lingual Proprioception in Pig, Dog and Cat

The muscle-spindles, shown by Cooper[1] to exist in the intrinsic tongue muscles of man and rhesus monkey, have not so far been satisfactorily demonstrated in other species.

Cooper has failed to find proprioceptive end-organs in the intrinsic musculature of the tongue in lamb and kitten, and this finding has been confirmed and extended by a histological survey of mammalian tongues in the course of this work.

However, the pattern of innervation in the tongues of pig, dog and cat suggests that proprioceptive impulses in these animals may be, at least in part, conveyed through a certain specialized form of receptor found in the intramuscular connective tissue, which is sufficiently constant in all three species to justify further attention.

Thick frozen sections, prepared by the diammine–silver ion method of Garven and Gairns[2], show that these end-organs are formed by a coil of axis-cylinder enclosed in an oval or pear-shaped capsule, which appears to be a terminal dilation of the neurilemma. The long axis of the capsule lies parallel to that of the muscle fibres. The endings occur mainly in the intrinsic muscles and are most abundant between the vertical and transverse groups, where they are closely associated with the strata of motor innervation in this region. A few endings were found in the inferior longitudinal muscle; none was noted in the superior longitudinal.

The structure and position of the intramuscular endings suggest that deformation of the capsule

resulting from muscular activity, may initiate low-threshold stimuli of a proprioceptive nature.

While histological evidence points to the derivation of the nerve-endings from fibres of the hypoglossal, it must be remembered that no conclusive evidence has been produced regarding an afferent component in this nerve. Boyd[3] alludes to the presence of Froriep's ganglion in the pig; but our examination of the hypoglossal in six infant pigs failed to reveal sensory cells on its intra- or extra-cranial fibres. This may be due to the general inconstancy of the ganglion, or to the immaturity of the subjects, and will require further investigation. In two of the animals, a well-marked group of sensory cells was noted on the extra-medullary fibres of the eleventh cranial nerve.

The function of tactile receptors in the regulation of tongue position must also be considered. In the animals examined, well-developed end-organs in the form of modified Meissner corpuscles were numerous in the dorsal mucosa of the posterior third of the tongue, and a few of similar character were observed near the tip.

It is perhaps significant that in the middle third of the tongue, where intramuscular connective tissue endings are most evident, no tactile corpuscles could be identified.

The investigation of lingual proprioception in mammals is being further pursued, the work being assisted by a grant from the Medical Research Council of Ireland.

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Presence of Zinc in Nucleoli and its Possible Role in Mitosis

The nucleolus is now believed to be composed mainly of ribonucleoproteins (Caspersson[1], Brachet[2]), although Vincent[3], who succeeded in isolating large quantities of nucleoli from starfish oocytes, concluded that the bulk of the nucleolus is phosphoprotein. On the other hand, Jacobson and Webb[4], like Zirkle[5] before them, indicated that some nucleolar substances (ribonucleoproteins) are contributed to the chromosomes during the mitotic cycle. Doubt exists, however, as to whether it is correct to regard ribonucleic acid and proteins as the only constituents that are important. We may suspect that other nucleolar substances which are less obvious play important parts in mitosis.

In a forthcoming paper, it has been shown[6] that zinc is found in considerable amount in the nucleoli of starfish oocytes. When the suspension of isolated nucleoli of the starfish oocyte, *Astropecten scoparius*, was allowed to stand with a small amount of 6 mgm./100 ml. dithizone solution in carbon tetrachloride for several hours, a deep-red colour was produced in the latter layer. This suggested that complex formation was occurring between zinc and this reagent within nucleoli. The proof that zinc is responsible for this dithizone reaction came from observations on polarograms. When the ash of the isolated nucleoli was analysed polarographically in the presence of zinc-free sodium acetate (*p*H 4·8), it gave a wave with a half-wave potential at − 1·05 V., suggesting that zinc was obviously reacting.

We have now proceeded some way with the analysis of the behaviour of the zinc during the mitotic cycle. It was found that when a small quantity of a saturated solution of diphenylthiocarbazone (dithizone) in 60 per cent alcohol, which was diluted with an equal volume of a borate buffer (*p*H 8·4), was added to the fertilized sea-urchin eggs, *Clypeaster japonicus*, on the slide, a purple colour was instantly developed within the nucleoli. The nucleoli of other forms, such as starfish oocytes and the staminal hair cells of *Tradescantia*, also stained purple, in marked contrast to the nearly colourless nuclear substance and cytoplasm.

We have further found that if sea-urchin eggs are treated with a small amount of alcoholic dithizone, mitosis proceeds practically normally, and the fate of the purple-staining substance can be traced throughout the mitotic sequence. It was found that the whole spindle first appeared faintly purple at about the time when the nucleolus disappeared (late prophase or prometaphase). The chromosomes were also seen to stain purple within the spindle. Whether spindle fibres were stained cannot be stated, although purple striations were often observed. It is interesting that the living spindle is clearly visible under these conditions. At metaphase, when the chromosomes were gathered at the equator of the spindle, they stained most deeply and appeared in greater relief under the ordinary microscope. They remained so during anaphase and gradually lost their purple-staining component as they swelled in telophase. It was possible to follow the movement of the faintly stained masses of chromosomes as they were incorporated into daughter nuclei. It appeared that the staining substance was then transferred from the chromosomes into the nuclear sap and finally consolidated into the nucleoli. It is of special interest to observe that the spindle as a whole became suddenly colourless at the beginning of anaphase, though in the final telophase some purple striations reappeared in the spindle region. Whether the centres or the centrioles stain cannot be decided. Since, however, the middle-piece and acrosome of the sperm were also found to be dithizone-positive (Fujii[6]), it is likely that the centres contain zinc. No evidence was found that asters are dithizone-positive.

These observations on the behaviour of nucleolar substance during mitosis are, of course, open to objections, since the dithizone reaction is not very specific and the chromosomes are too small to draw any definite conclusions. But the evidence so far obtained suggests that zinc is present in nucleoli and that, upon the initiation of mitosis, it passes into the chromosomes and possibly also into the prometaphase spindle.

Lastly, we may suggest that the behaviour of the zinc is related in some way to the reversible denaturation of active proteins, which might be involved in the physical changes of chromosomes and of the spindle during mitosis, for we are obtaining evidence that a parallel exists between the unmasking of —SH groups and the release of zinc from some tissues. It is likely that zinc is only released in catalytic quantities from nucleoli or from chromosomes, and is acting as what Swann[7] calls a 'structural agent'. Structural changes of chromosomes during mitosis, which are interpreted by Kuwada[8] as due to hydration

and dehydration, may also be explained by this hypothesis.

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Stability in Development and Relational Balance of X-Chromosomes in *Drosophila melanogaster*

Mather[1] has shown that asymmetry of sternopleural chæta number in *Drosophila melanogaster* is subject to genetically controlled variation and is a valid measure of the capacity of the genotype to promote stabilization or canalization of the development of the individual. The following results show effects on asymmetry of *X*-chromosomes extracted from four different experimental populations.

Two of these populations have been maintained at a constant 25° C. and the other two have spent each day at 25° C. and each night at 15° C. (For the present purpose, however, these should merely be regarded as two different environments, for their mean temperatures are different and there is no check that any difference due to environments arises from the fluctuation in temperature rather than the mean.) The populations were all started at the same time from a combination of the same two laboratory stocks, one homozygous for w^a and the other for w. (The effects of selection on this locus have already been reported[2].)

After the populations had been maintained for sixteen months, w^a males were extracted from each of them and mated to Muller-5 females. The *X*-chromosomes from these males were then maintained by continually backcrossing the heterozygous w^a/Muller-5 females to stock Muller-5 males. It had been intended to control chromosomes II and III using balancers, but the appropriate crosses gave difficulty so that backcrossing was relied on to give reasonably uniform genetic backgrounds. After five generations of backcrossing, the *X*-chromosomes were tested by matings that would produce females homozygous for a particular *X*-chromosome (*H* flies), matings that would produce females heterozygous for *X*-chromosomes from the same population (intra-population heterozygotes : *I* flies) and matings that would produce females heterozygous for *X*-chromosomes from different populations that had been maintained in the same environment (extra-population heterozygotes : *E* flies). The experiment involved replicate cultures (apart from failures), three chromosomes from each population, and each chromosome or combination was tested in each of the two environments. The experiment was repeated after a further generation of backcrossing. Ten w^a/w^a females were counted from each culture, and the sum of their arithmetical asymmetries was used as the datum for analysis. (It should be noted that the measure of asymmetry used for this preliminary report differs from that used by Mather.)

Table 1

Type of female	Environment of test culture	Environment of population from which *X*-chromosomes were extracted: 25° C.	Fluctuating	Total
Homozygotes (*H*)	Home	189	174	363
	Foreign	221	230	451
	Total	410	404	814
Intra-population heterozygotes (*I*)	Home	194	157	351
	Foreign	162	180	342
	Total	356	337	693
Extra-population heterozygotes (*E*)	Home	236	230	466
	Foreign	224	218	442
	Total	460	448	908
	Total, Home	619	561	1,180
	„ Foreign	607	628	1,235
	Total	1,226	1,189	2,415

Table 2

Source	Sum of squares	*n*	Mean square	Correct *F*	Correct *p*
Type of fly (*HIE*)	242·0208	2	121·01	26·08	<0·001
Env. of population (*EP*)	4·7535	1	4·75	1·02	—
Env. of test culture (*EC*)	10·5028	1	10·50	2·26	>0·05
HIE × *EP*	0·8820	2	0·44	—	—
HIE × *EC*	70·6534	2	35·33	7·61	<0·001
EP × *EC*	21·6708	1	21·67	4·67	<0·05
HIE × *EP* × *EC*	22·1938	2	11·10	2·39	>0·05
Repetitions	12·0868	1	12·09	2·71	>0·05
Residual* (error)	1,105·4549	238	4·64		
Total	1,490·2188	250†			

* Differences between cultures (that is, within chromosomes) give a slightly larger mean square than all other residual differences combined. Hence a combined error is used.
† Of the 288 cultures, 37 failed.

Table 1 gives the pooled results, the environments of the test cultures being classified into 'home' (the same as that of the population from which the tested *X* was obtained) and 'foreign'. Table 2 gives the results of analysis of variance of the 288 culture results. There are two highly significant items, the *HIE* comparison and the interaction *HIE* by culture environment.

All three items involved in the *HIE* comparison are significantly different from one another. (This variation of asymmetry is not a result of variation of mean bristle number. The mean bristle numbers per fly are *H* 16·2335, *I* 16·2296 and *E* 16·2069.) The significant interaction arises because the homozygotes are specifically adapted to the 'home' environment, whereas *I* heterozygotes are as well-adapted to either environment as are homozygotes to the 'home' environment and *E* heterozygotes are as ill-adapted to either environment as the homozygotes to the 'foreign' environment.

We may assign 1 as a measure of the stability of homozygotes in their 'home' environment and 0 as a measure of their stability in the 'foreign' environment. The significant differences and the similarities can then be summarized as follows :

Type of fly	Culture environment: Home	Foreign	Total
Homozygotes	1	0	1
Intra-population heterozygotes	1	1	2
Extra-population heterozygotes	0	0	0

A number of points emerge:

(1) The homozygotes are as stable in development as any other type in the home environment. This stability presumably depends upon an internal balance[2] and is not surprising since, if the *X*-chromosome is to contribute to stability, it must operate in the hemizygous male as well as in the female.

(2) The intra-populational heterozygotes are equally stable in the foreign environment (they are phenotypically flexible in the sense of Thoday[4], or homeostatic in the sense of Dobzhansky and Wallace[5]). Their stability in the foreign environment does not depend upon their internal balance since it is not reproduced by the homozygotes. Neither does it depend on some virtue of heterozygosity *per se* as Robertson and Reeve[6] have suggested, for it does not extend to the extra-populational heterozygotes. It clearly depends on the fact that the chromosomes contained in the heterozygotes have evolved in relation to one another through the operation of natural selection in a single population of outbreeding organisms producing relational balance in Mather's sense[3].

(3) Despite the fact that both the chromosomes involved have internal balances conferring stability to the same environment, the extra-population heterozygotes are unbalanced in the home environment: in this environment they show negative heterosis, underlining the conclusion that positive heterosis depends upon relational balance. These *E* heterozygotes are also no better than the homozygotes in the foreign environment, though no doubt some environment might be found in which the homozygotes are inferior.

Contemporary genetical research is rapidly producing example after example in which heterozygotes are proving to have smaller non-genetic variances than have corresponding homozygotes, and there is a danger that it may be concluded that heterozygosity necessarily promotes homeostasis. The present results indicate that, sometimes at least, relational balance is necessary, and that some homozygotes can be superior to comparatively unbalanced heterozygotes.

Mather (ref. 1, pp. 330, 331) has already discussed the relationship between selection, breeding system and stability of development and suggested that superior stability of heterozygotes is less likely in naturally inbreeding organisms. The present results provide an illustration of a similar principle.

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Liberation of Amino-acids by Plant Roots in relation to Desiccation

Previous reports from this laboratory[1–5] have shown that in the rhizosphere, or zone of influence of the roots of growing plants, there is a preferential stimulation of bacteria requiring amino-acids for maximum growth. This communication concerns the production of amino-acids by roots of several kinds of plants in an attempt to explain, at least in part, the preferential effect noted on this group of organisms.

Although frequent mention is made of excretion of organic substances by roots, there is surprisingly little information as to the extent of such excretion or the nature of the substances liberated. There is certainly very little evidence of excretion of amino-acids by roots of non-legumes, although Kandler[6] has reported recently the liberation of amino-acids by excised roots of maize. The production of certain specific amino-acids by roots of legumes, as shown by Virtanen and his group, may be considered a special case, since it involves a symbiotic relationship with the nodule bacteria. It may be postulated that amino-acids are produced in the rhizosphere in amounts which would permit growth of amino-acid-requiring bacteria, by a number of agencies only one of which may be excretion from intact roots. They may also be liberated from sloughed-off root caps, root hairs or epidermal cells and by the decomposition of these root fragments, and of microbial protoplasm. In addition, they may arise through microbial synthesis, for there is some evidence that bacteria with simple nutritional requirements, also stimulated in the rhizosphere, liberate amino-acids which can be used by the amino-acid-requiring bacteria[3]. Preliminary experiments with six- to eight-week-old soybean, tomato and wheat plants showed that these could absorb known amino-acids through their leaves and that these acids were recoverable in the dilute mineral solution in which the roots were immersed. It was also noted that even roots of control plants, not fed amino-acids, contributed variable, though small, amounts of ninhydrin-positive substances to the mineral solution. When such roots were allowed to dry and then remoistened, a striking increase in amino-acids was observed. In normal field conditions, plant roots are subjected to desiccation and remoistening. In the light of the above observation, this may contribute significant amounts of amino-acids for the rhizosphere microflora and thus account in part for the preferential stimulation of amino-acid-requiring bacteria.

Further data on the nature of the amino-acids liberated and the extent of such production were obtained from plants grown in thoroughly washed sand moistened with a suitable mineral solution. After these plants were six to eight weeks old, the pots were divided into two lots, one of which was allowed to dry out and the other kept moistened. When the sand was dry and the plants showed signs of wilting, all pots were brought up to their original weight, and after one hour leached with water; 200 ml. was collected from each pot and the leach water filtered through paper. One portion was concentrated *in vacuo* for chromatographic and total amino-nitrogen analysis, and the remainder dispensed into test-tubes and sterilized after the addition of 0·1 per cent glucose. These tubes were inoculated with selected amino-acid-requiring bacteria. The results of amino-nitrogen analysis by heating with ninhydrin[7] and determining the intensity of the resulting colour at 540 mμ in a Klett–Summerson photoelectric colorimeter are given in Table 1. It is clear that appreciable amino-nitrogen was elaborated in sand which was dried and remoistened in the presence of the plant root system, but not in sand, treated similarly, after the plants had been removed. These results were confirmed by means of paper chromatography, which showed a variety of amino-acids in the leach water of treatment 2, including glutamic and aspartic

acids, leucine, alanine, cysteine, glycine, lysine, phenylalanine and proline (isatin spray). Still further corroboration was provided by the observation that by far the best growth of the amino-acid-requiring bacteria tested occurred in the leach water of treatment 2. Similar experiments were set up with 50 per cent sand–soil mixtures with essentially similar results. Of interest, too, is the evidence of the presence of ninhydrin-reactive material in the leach waters of pots kept moist throughout the duration of the experiment, suggesting that even such plants may liberate amino-nitrogen, perhaps by sloughing off root fragments. Experiments under way with completely sterile systems indicate that small amounts of ninhydrin-positive substances are produced by roots under these conditions also.

Table 1. Liberation of Amino-acids by Plant Roots

Treatment	Total amino-nitrogen* (optical density at 540 mμ)			
	Tomato	Soybean	Barley	Oats
1. Dried sand, remoistened after plants removed	5	0	0	0
2. Dried sand with plants; remoistened	67	209	193	287
3. Wet sand, after plants removed	5	10	0	2
4. Wet sand, with plants	10	10	0	2

* Average of triplicate tests

The presence of a reducing compound with an R_F value identical with that of glucose has also been observed in the leach waters (treatment 2, Table 1) of the four plants studied.

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Variation of the Shells of *Murex tribulus* from the Great Bitter Lake, Egypt

On the shore of the Great Bitter Lake in the neighbourhood of Fayid, the most conspicuous member of the molluscan fauna is a gastropod which, according to the authorities at the British Museum (Natural History), belongs to the species *Murex tribulus*. The shells at once attract attention by their remarkable variability.

To the student of variation in animals, the shells are of particular importance inasmuch as the varying features are of such a nature as to facilitate accurate observation, exact measurement and reliable record. Among these features, apart from variation in size, shape and in the proportions of the various parts, the most conspicuous are the numerous blunt spines projecting from the shell and playing a main part in giving the shell its very characteristic appearance. It is these spines, too, which provide material of special importance to the student of variation.

The material for this study consists of a collection of some three hundred shells made by Sir John Graham Kerr while staying at Fayid during the early months of 1951 and 1953. The collection is now in the Science Department of the College of Notre Dame, Dowanhill, Glasgow.

The details of a typical shell are shown in Fig. 1 (upper). The spines are arranged in rows, each row corresponding to a varix, three large to each whorl of the shell. A ridge or rows of tubercles is continuous between each spine and the corresponding spine of the next whorl, those connecting the large spines being more prominent than those connecting the small ones. The body whorl of the shell is drawn out into the tapering anterior canal bearing spines, except at the extreme tip. This carries the siphon and therefore in life is lined by the mantle. Variation occurs in the length of the anterior canal between about 5 and 39 per cent of the total length of the shell, and markedly also in the length of the portion free from spines, this portion being so short in some cases as to give the shell a truncated appearance. Examination of the individual spines shows that they vary greatly—in length—from a mere tubercle up to about 12 mm., and in the angles at which they spring from the surface of the shell. Examination of a corresponding spine in the various shells showed that this angle varied between 22° and 53°.

An elaborate and detailed study of the whole collection has been carried out by Sister M. Josephine Parkes. Most regrettably, the publication of her valuable paper, illustrated by beautiful photographs by Dr. H. F. Steedman, of the Department of Zoology, University of Glasgow, has been held up for the time being.

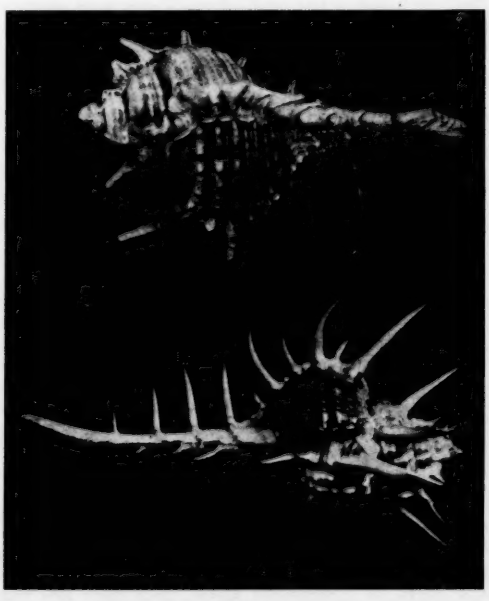

Fig. 1

The Bitter Lakes occupy part of the channel of what once formed a communication between the Red Sea and the Mediterranean. At the time of the cutting of the Suez Canal in 1869, the site of the Bitter Lakes was dry land; but the opening of the Channel into the Gulf of Suez admitted the waters of the Red Sea, and the Bitter Lakes came into being. As time went on they became colonized by immigrant organisms from the Red Sea and among these was *Murex tribulus*.

The collection and preliminary study of the shells from Fayid were made in ignorance of the Red Sea forms from which they were presumably derived. It was therefore with much interest that specimens from the Red Sea were later examined. In these the blunt spines of the specimens from the Great Bitter Lake were found to be sharply pointed, as shown in Fig. 1 (lower). This specimen came from the shallow waters between the coast and the coral reef at Hurghada. There these spines may well constitute a most effective armature against the voracious enemies among which this species lives.

I have to thank Mr. D. E. Morgan, of the Anglo-Egyptian Oilfields, Ltd., for facilitating the collection of 185 specimens from Hurghada on the west side of the Red Sea close to the opening of the Gulf of Suez, and 114 from Ras Matarma on the east side of the Gulf of Suez. To him and his colleagues and to many others who have responded to my appeal in *Nature*[1], I must extend my warmest thanks.

To the general zoologist, the facts summarized here are of great interest. *Murex tribulus* is an organism which by its perfect adaptation has been able to survive and flourish amid all the complexities and dangers incidental to the luxuriant and varied fauna inhabiting the coral reefs and their immediate neighbourhood. The Fayid specimens represent members of the species that have wandered into the placid environment of the Bitter Lakes with their comparatively sparse fauna; and the lesson they teach is how a species, freed from the shackles of the environment to which it has been through long ages adapted, gives way to the general instability of living substance and shows untrammelled variability.

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A Hydropolyp in the Biological Cycle of a Freshwater Jellyfish

During investigations on the invertebrates of Lake Tanganyika we have been able to find all the stages of the sessile generation of the well-known Tanganyikan Trachymedusan *Limnocnida tanganyicae* Günther. We have also collected them in Lakes Mohasi and Sake (Ruanda), where the sexual reproduction seems to be more important. These hydropolyps are completely invisible when living and must be treated first with some fixative (Bouin's or Zenker's fluids); they are very minute (less than 0·5 mm. for one individual) and transparent.

Exceedingly voracious, they feed on midge larvæ. They live in quiet places (Gulf of Burton) in Lake Tanganyika, or in calm lakes (such as Mohasi or Sake). They attach themselves principally around the septa of *Phragmites* stems, and they are very often mixed with colonies of Bryozoa.

In Lake Mohasi, sexual reproduction takes place from mid-April to the beginning of September. In Lake Tanganyika it only begins at the end of May.

This finding shows that, contrary to the marine Trachymedusa, most of the freshwater forms have a sessile sexual stage.

The complete study of this sexual generation will be published elsewhere.

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Scientifique en Afrique Centrale,
Centre de recherche de Tanganyika,
Uvira.
July 12.

"Sixth Commonwealth Entomological Conference"

In the account in *Nature* of September 18, p. 541, of the Sixth Commonwealth Entomological Conference, I am reported as saying that the results of insecticides used against tsetse fly suggest that tsetse populations "may be unable to recover after reduction below a certain level".

My point was quite different. It was that the tsetse population might be found to maintain itself permanently at *any* level (above, of course, a low minimum) to which the insecticide had reduced it. This idea, first put forward by me in 1937 (*Proc. Zool. Soc. Lond.*, 1936, 811, Section X), is now supported by some of the findings of the East African Colonial Insecticides Research Unit (Hocking, Parr, Yeo and Anstey, *Bull. Ent. Res.*, **44**, 627; 1953), and has the greatest practical importance as, for example, when a few flies straggle back across a barrier into country from which they had previously been evicted.

C. H. N. Jackson
(Chief Entomologist)
Central Tsetse Research Laboratory,
P.O. Shinyanga,
Tanganyika Territory.

It is regretted that, in the attempt to convey in a few lines the gist of long and complex discussions, Dr. Jackson has inadvertently been misrepresented. The relevant passage in his paper is as follows: "To my mind, the fundamental fact arising from all this work is that isolated tsetse populations by no means always tend to recover, when applications of insecticide cease." At an earlier meeting, Dr. Jackson had indicated more precisely the point he now emphasizes, namely, that the results of insecticide experiments seem to confirm his view that the size of tsetse populations is not controlled by density-dependent factors. The discussion, however, had been principally directed to the question, which he now dismisses in a parenthesis, of whether there was a *minimum* size of stable population of tsetse. It was suggested that a percentage reduction of the order that can be achieved by insecticides might, with an initially small population, result in a density so low that the fly could not maintain itself, particularly—as Dr. Jackson pointed out—if the environment were then altered by settlement. It was this thought, which was evidently felt to be of the highest practical importance, that the offending sentence sought to convey.

The Writer of the Article

FORTHCOMING EVENTS

(Meetings marked with an asterisk • are open to the public)

Monday, December 13

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 4 p.m.—Dr. Donald Hunter: "Lung Disease due to Dusts".•

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Prof. J. Z. Young, F.R.S.: "Memory" (Ramsden Memorial Lecture).

INSTITUTE OF METAL FINISHING (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr. H. Silman: "Recent Developments in Chromium Plating".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 8 p.m.—Prof. C. H. Waddington, F.R.S.: "The Philosophic Bearing of some Recent Ideas on Evolution".

Monday, December 13—Tuesday, December 14

PHYSICAL SOCIETY (in the Poynting Physics Building, The University, Birmingham)—Autumn Meeting on "A Survey of Field Theory".

Tuesday, December 14

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. G. W. Jull: "The Ruthemann Spectra of Electrons".

INSTITUTION OF CHEMICAL ENGINEERS (joint meeting with the CHEMICAL ENGINEERING GROUP, SOCIETY OF CHEMICAL INDUSTRY, and the INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. Ewen McEwen and others: "The Drying of Wheat Grain".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Dr. F. M. Lea: "Experimental Science and Civil Engineering Research" (Unwin Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. G. W. Bowdler: "An Attracted-Disc Absolute Voltmeter"; Mr. M. E. Haine and Mr. M. W. Jervis: "The Use of an Electron Velocity Analyser to Stabilize a 50 kV. D.C. Voltage Source to a Few Parts in a Million"; Mr. M. W. Jervis: "A Precision Direct-Current Stabilizer".

INSTITUTION OF THE RUBBER INDUSTRY (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. S. Mottram: "Compounding the Vinyl Polymers". 7 p.m.—Dr. F. M. Merrett and Mr. R. I. Wood: "Polymer-modified Natural Rubber".

Tuesday, December 14—Wednesday, December 15

NATIONAL INSTITUTE OF AGRICULTURAL BOTANY (at the Cambridge Union Society, Bridge Street, Cambridge)—Third Crop Conference—"Crops for Home Feeding".

Wednesday, December 15

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Prof. A. Wormall: "Isotopes in Medical Investigation".•

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. H. G. Reading: "The Stratigraphy and Structure of the Cotherstone (Stainmore) Syncline"; Dr. D. A. Robson: "A Sedimentary Study of the Fell Sandstones of the Coquet Valley, Northumberland".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Scientific Papers.•

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion on "The Ecology of Some Arthropod-borne Diseases of Man and Animals". Opening Speakers: Prof. P. A. Buxton and Prof. G. W. A. Dick.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Discussion on "Current Population Problems with particular reference to the U.N. World Population Conference". Opening Speakers: Mr. B. Benjamin, Prof. E. Grebenik, Dr. W. P. D. Logan, Prof. Brinley Thomas, Mr. J. Hajnal and Dr. J. A. Fraser Roberts.

EUGENICS SOCIETY (at the Rooms of the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Peter R. Cox: "Some Demographic Developments in Great Britain since the Royal Commission on Population".•

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Mr. R. A. Bull: "Modern Trends in Motion Picture Sound".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. A. F. Hughes: "The Growth of the Neurone".

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Prof. A. M. Taylor: "Photoelectric Measurement of Polarized Light".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. C. E. Richards: "The Prevention of Corrosion in the Telecommunications Industry".

Thursday, December 16

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. M. F. Atiyah: "Recent Developments in Algebraic Geometry".

ROYAL AERONAUTICAL SOCIETY (at Church House, Great Smith Street, Westminster, London, S.W.1), at 5.15 p.m.—H.R.H. The Duke of Edinburgh—Tenth British Commonwealth and Empire Lecture.

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Dr. H. H. Scholefield: "Melting and Casting under Reduced Pressure".

INSTITUTION OF MECHANICAL ENGINEERS, INTERNAL COMBUSTION ENGINE GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Group Discussion—"It is Often Stated, Usually by 'Scientists', that Industry is Slow to Apply New Scientific Discoveries and Data, both in Regard to Materials and Design. Is this True of the Internal Combustion Engine World?"

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. G. R. Clemo, F.R.S.: "Some Newer Aspects of the Organic Chemistry of Nitrogen" (Hugo Müller Lecture).

Thursday, December 16—Friday, December 17

INSTITUTE OF PHYSICS, STRESS ANALYSIS GROUP (in the Central Chemistry Lecture Theatre, The University, Reading), at 9.30 a.m. daily—Conference on "Stresses Due to Vibration".

Friday, December 17

BIOCHEMICAL SOCIETY (at Guy's Hospital Medical School, St. Thomas Street, London, S.E.1), at 2 p.m.—Scientific Papers.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. C. S. Durst: "The Accuracy of Dead Reckoning in Air Navigation".

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. F. P. Bowden, F.R.S.: "Recent Studies of Metallic Friction" (Thomas Hawksley Lecture).

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Strand, London, W.C.2), at 6 p.m.—Mr. B. C. Vickery and Dr. G. Malcolm Dyson: "Advances in Classification".

INSTITUTE OF PHYSICS, NON-DESTRUCTIVE TESTING GROUP (at 47 Belgrave Square, London, S.W.1) at 6.30 p.m.—Mr. E. F. Priestley: "X-Ray Fluorescence Analysis".

Saturday, December 18

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. T. L. Bartlett: "The Black-Headed Gull".•

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (graduate, with teaching experience) IN PHYSICAL GEOGRAPHY, at Gadjah Mada University, Jogjakarta, Indonesia—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting "Indonesia" (December 17).

LECTURER IN PHYSICS—The Registrar, Queen Mary College (University of London) Mile End Road, London, E.1 (December 18).

LECTURER (with a degree in agriculture and some postgraduate experience) IN AGRICULTURE AND DIRECTOR OF THE COLLEGE FARM at Nafferton—The Registrar, King's College, Newcastle-upon-Tyne (December 18).

ASSISTANT LECTURER or LECTURER (well qualified in metallurgy, physics or physical chemistry) IN METALLURGY—The Registrar, The University, Leeds 2 (December 20).

LECTURER (graduate, with experience in industrial engineering and research) IN MECHANICAL ENGINEERING—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (December 20).

LECTURER IN BACTERIOLOGY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 20).

LECTURER (with a recognized degree or diploma in agriculture) IN AGRICULTURE—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford (December 20).

ASSISTANT (graduate in chemistry or biochemistry) IN BIOCHEMISTRY, at the Biochemical Laboratory of the Institute of Orthopædics, Brockley Hill, Stanmore, for research work—The Dean, Institute of Orthopædics, 234 Great Portland Street, London, W.1 (December 31).

DIRECTOR (with high scientific attainments, preferably in fields related to soils or crops, combined with administrative experience involved in the organization and running of a research institute or university department) OF THE EAST AFRICAN AGRICULTURE AND FORESTRY RESEARCH ORGANIZATION, Muguga, near Nairobi, Kenya—The Director of Recruitment (Her Majesty's Oversea Civil Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.195/151/02 (December 31).

LAND DEVELOPMENT OFFICERS (with a degree or diploma in agriculture, and preferably with several years farming experience) IN

THE DEPARTMENT OF NATIVE AGRICULTURE, Southern Rhodesia—The Secretary, Southern Rhodesia Government, Rhodesia House, 429 Strand, London, W.C.2 (December 31).

RESEARCH ASSISTANT (graduate in natural science or in agricultural science, and a thorough grounding in entomology, plant pathology, systematic botany, and organic and inorganic chemistry) IN THE DEPARTMENT OF AGRICULTURE; and an INSTRUCTOR IN AGRICULTURE (preferably with teaching experience and a degree or diploma in tropical agriculture) IN THE EDUCATION DEPARTMENT, to teach general tropical agriculture, both theoretical and practical, in close association with the Department of Agriculture—Public Service Commissioner, Western Samoan Public Service, Apia, Western Samoa (December 31).

DIRECTOR OF THE TEA RESEARCH INSTITUTE OF CEYLON—The Chairman, Tea Research Institute of Ceylon, St. Coombs, Talawakelle, Ceylon (January 1).

LECTURER IN BACTERIOLOGY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (January 8).

LECTURER/SENIOR LECTURER IN PALAEONTOLOGY, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 8).

CHAIR OF ELECTRICAL ENGINEERING, and CHAIR OF CIVIL ENGINEERING—The Registrar, The University, Sheffield 10 (January 15).

DRUMMOND FELLOWSHIP FOR RESEARCH IN NUTRITION—The Hon. Secretary, Drummond Trust, University College, Gower Street, London, W.C.1 (January 15).

SENIOR TECHNICAL OFFICER or PRINCIPAL TECHNICAL OFFICER (with a degree in science or equivalent qualifications, and with experience in the collection of samples and the complete analysis of coal), IN THE COAL RESEARCH SECTION, Commonwealth Scientific and Industrial Research Organization, North Ryde, New South Wales, Australia, to supervise the collection, preparation, testing and chemical analyses of coal samples in connexion with the Sections survey of the physical and chemical properties of Australian coals—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 480/152 (January 15).

CHAIR OF MINING ENGINEERING at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, January 31).

AGRICULTURAL ENGINEER (with at least a first-class degree in agricultural engineering, and practical experience in farming methods), to be responsible for the development of the agricultural and engineering aspects of tillage and all phases of tobacco production, and the modification of existing equipment and machinery—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (February 15).

AERODYNAMICISTS, MECHANICAL AND ELECTRICAL ENGINEERS, PHYSICISTS and PHYSICAL CHEMISTS (with an appropriate first- or second-class honours degree or equivalent qualifications) at the Ministry of Supply National Gas Turbine Establishment, near Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.780/54A.

CHEMIST-ASSAYER (with an honours or special degree in chemistry, and at least two years postgraduate experience in silicate analysis and assaying) IN THE GEOLOGICAL SURVEY DEPARTMENT, Gold Coast Government, to assay ore of all kinds and carry out silicate analysis of rocks and minerals, and to participate in research in the interrelation of Gold Coast rocks and in geochemistry—The Adviser on Recruitment, Gold Coast Office, Melbourne House, Aldwych, London, W.C.2.

DEMONSTRATOR (with an honours degree in physics) IN PHYSICS, at the Royal Military College of Science, Shrivenham—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.340/54A.

HEAD OF THE DEPARTMENT OF BIOLOGY, Technical College, Bradford—The Director of Education, Town Hall, Bradford.

LABORATORY ASSISTANT (male) IN THE HUMAN PHYSIOLOGY DIVISION, Medical Research Council Laboratories, Holly Hill, Hampstead, N.W.3—The Administrative Officer, National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7, quoting AD/49.

PHYSICIST (with a good honours degree in physics) to assist in radium and X-ray problems, including rotational therapy, as well as radio-isotope work—The Director, Cancer Organization, Newcastle Regional Hospital Board, 3 Windsor Crescent, Newcastle-upon-Tyne 2.

RESEARCH ASSISTANTS (2) IN THE IRON MAKING DIVISION, for work on problems concerning the preparation and smelting of iron ores—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Iron Making".

RESEARCH FELLOW, to assist Dr. P. A. Gorer with work on the serological study of transplantation immunity—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1.

SENIOR INVESTIGATORS and RESEARCH ASSISTANTS (with a degree in metallurgy, physics or engineering, or equivalent qualifications) IN THE DEPARTMENT OF INDUSTRIAL METALLURGY, for research on (*a*) the microstructure and properties of electro-deposits (under the direction of the Joseph Research Fellow); (*b*) the fatigue of light alloys; and (*c*) the production and properties of clad metals—The Acting Registrar, The University, Edgbaston, Birmingham 15.

SENIOR LECTURER or LECTURER (with teaching, research and/or industrial experience in electronics) IN PHYSICS—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3.

SENIOR RADIATION CHEMIST (with ample experience in radiation chemistry and able to tackle any industrial problem in this field), to be responsible for a small group of chemists; a PHYSICIST (with experience in nuclear physics), to design new irradiation sources and investigate irradiated products; and a BIOLOGIST (preferably with experience in radiation damage work), to collaborate with industrial concerns on the irradiation of foodstuffs and drugs—The Establishments Officer, United Kingdom Atomic Energy Authority, Research Group, Harwell, Didcot, Berkshire, quoting 2/103/167.

SENIOR TECHNICIAN (familiar with, and experienced in, laboratory techniques), to assist in research on the linear accelerator—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1, quoting "Senior Technician".

REPORTS and other PUBLICATIONS

(not included in the Monthly Books Supplement)

Great Britain and Ireland

University of London. University College Calendar, 1954–55. Pp. lxiv+482. (London: University College (University of London), 1954.) [1110

Agricultural Research Council: Soil Survey Research Board. Soil Survey of Great Britain—Report No. 6. Pp. iv+35. (London: H.M. Stationery Office, 1954.) 4*s.* 6*d.* net. [1110

Imperial Forestry Institute: University of Oxford. Institute Paper No. 31: The Growth and Mineral Nutrition of Spruce and Pine in Heathland Plantations. By L. Leyton. Pp. 109+7 plates. (Oxford: Imperial Forestry Institute, University of Oxford, 1954.) 12*s.* 6*d.* [1110

Department of Scientific and Industrial Research. Forest Products Research Bulletin No. 32: Field Tests on Wood Preservatives Used for Pressure Treatment. By D. N. Smith. Pp. iv+52+1 plate. (London: H.M. Stationery Office, 1954.) 2*s.* 6*d.* net. [1110

North Staffordshire Field Club. Transactions and Annual Report, 1952–53. (Volume 87.) Edited by H. V. Thompson. Pp. 109+B51–74+1 plate. (Stoke-on-Trent: North Staffordshire Field Club, 1954.) 10*s.* 6*d.* [1110

Proceedings of the Toronto Meteorological Conference 1953, held from 9 to 15 September 1953, by the American Meteorological Society and the Royal Meteorological Society. Pp. 294+5 plates. (London: Royal Meteorological Society, 1954.) 30*s.* [1110

Textile Terms and Definitions. Pp. 46. (Manchester: The Textile Institute, 1954.) [1110

Handbooks for the Identification of British Insects. Vol. 10, part 4 (*a*): Diptera Cyclorrhapha Calyptrata (1). Section (*a*): Tachinidae and Calliphoridae. By F. I. van Emden. Pp. 134. (London: Royal Entomological Society of London, 1954.) 20*s.* [1110

Proceedings of the University of Durham Philosophical Society. Vol. 11, No. 10: The Calamine Mines, Malham, Yorks. By Dr. A. Raistrick. Pp. 125–130. Vol. 11, No. 11: Insects from a Travertine Deposit in Upper Teesdale. By F. H. Rhodes. Pp. 131–134+2 plates. Vol. 11, No. 12: Botanical Investigations in the Isles of Lewis, Harris, Taransay, Coppay and Shillay in 1953. By Dr. J. W. Heslop Harrison. Pp. 135–142. (Durham: University of Durham Philosophical Society, 1954.) [1110

Other Countries

Conseil Permanent International pour l'Exploration de la Mer, Charlottenlund Slot, Danemark. Rapports et Procès-Verbaux des Réunions. Vol. 136—The Cod. (Contributions to Special Scientific Meetings, 1953.) Pp. 102. (Copenhague: Andr. Fred. Høst et Fils, 1954.) 18 kronor. [1110

State of California: Department of Fish and Game. Fish Bulletin No. 96: California Fishing Ports. By W. L. Scofield. Pp. 163. (San Pedro, Calif.: California State Fisheries Laboratory, Terminal Island Station, 1954.) [1110

Institut Royal Météorologique de Belgique. Publications Séries B, No. 11: Les Caractères Climatiques de la Période 1939–1953 et le Temps en 1953. Par R. Sneyers. Pp. 52. Contributions, No. 13: Technique et Problèmes des Sondages Aérologiques. Par L. M. Malet. Pp. 16. (Uccle-Bruxelles: Institut Royale Météorologique de Belgique, 1954.) [1110

Yale Peabody Museum of Natural History. Postilla. No. 14, December 15, 1952: A New Race of Black-Throated Babbler from Assam. By S. Dillon Ripley. Pp. 2. No. 15, May 12, 1953: *Typothorax* Scutes from Germany. By Joseph T. Gregory. Pp. 6. No. 16, June 3, 1953: Typothorax and Desmatosuchus. By Joseph T. Gregory. Pp. 27. No. 17, December 18, 1953: Notes on Indian Birds—5. By S. Dillon Ripley. Pp. 4. No. 18, March 6, 1954: Three New Birds from the Yucatan Peninsula. By Raymond A. Paynter, Jr. Pp. 4. No. 19, July 9, 1954: Birds from Gough Island. By S. Dillon Ripley. Pp. 6. No. 20, July 9, 1954: Notes on Indian Birds—6: Additional Comments on the Wren-Babbler, *Spelaeornis*. By S. Dillon Ripley. Pp. 4. (New Haven, Conn.: Yale Peabody Museum of Natural History, 1952–1954.) [1110

Smithsonian Miscellaneous Collections. Vol. 123, No. 2: The Dragonfly Larva. By R. E. Snodgrass. Pp. iii+38. (Publication 4175.) (Washington, D.C.: Smithsonian Institution, 1954.) [1110

U.S. Department of Commerce: National Bureau of Standards. Handbook No. 58: Radioactive-Waste Disposal in the Ocean. (Recommendations of the National Committee on Radiation Protection.) Pp. iv+31. (Washington, D.C.: Government Printing Office, 1954.) 20 cents. [1110

United States Department of Agriculture. Circular No. 942: The Beet Leafhopper. By J. R. Douglass and W. C. Cook. Pp. 21. (Washington, D.C.: Government Printing Office, 1954.) 15 cents. [1110

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